Compressed Air Magazine

MAY 1961

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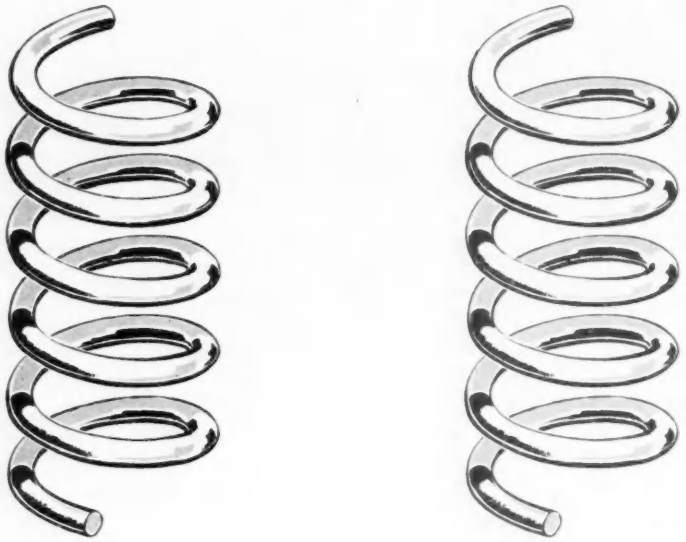

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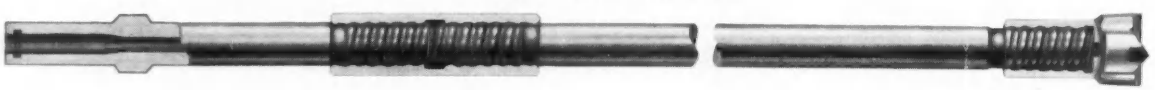

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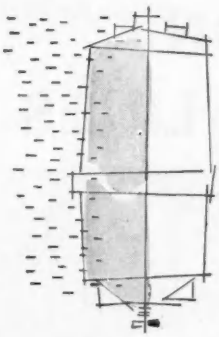

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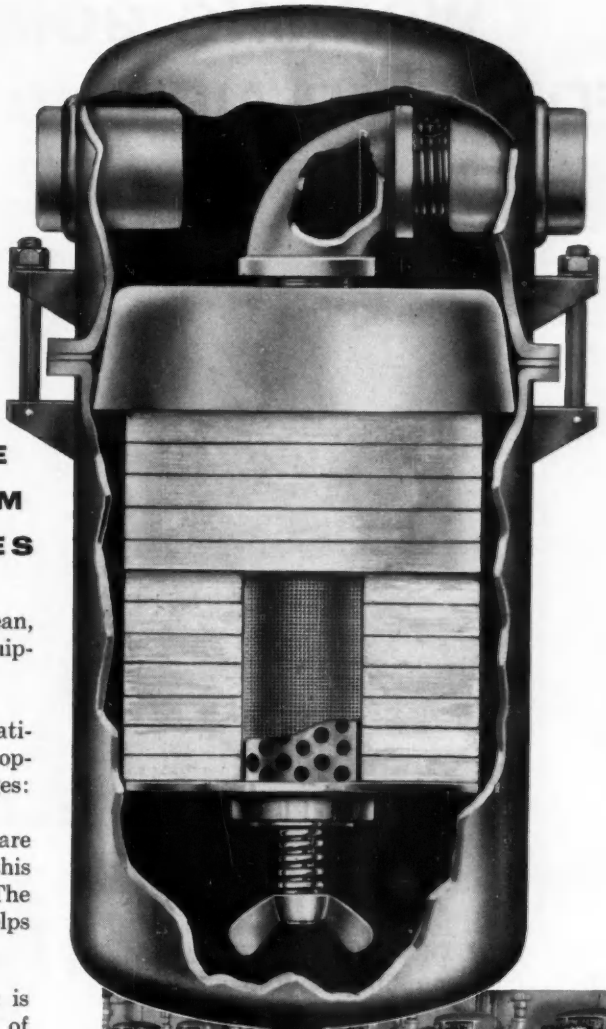

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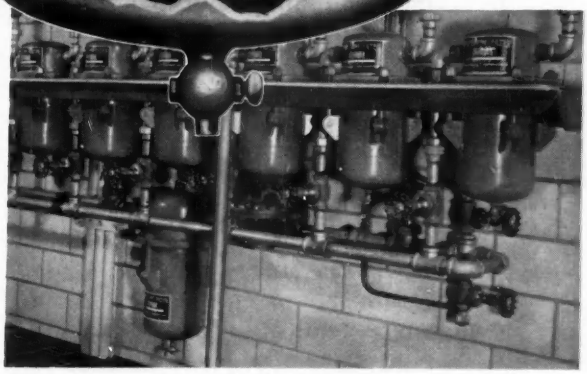

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on the cover

Chap on the cover is giving the inside of a stainless steel "tunnel" a good sandblasting. Actually it's not a bore at all but a $52^1/_2$-foot vessel that is built to store liquid oxygen at missile bases. Sanding is the first of several operations that will leave the interior spotlessly clean. Allegheny Ludlum Steel Corporation supplies the stainless and the manufacturer is Struthers Wells Corporation. You can't see it, but the sandblast operator is shod with polyethylene shoe covers—another cleanliness precaution.

6 Blasting Away a Bottleneck—G. R. Smith

A $3,000,000 bridge approach and toll plaza, where U. S. Route 22 crosses the Delaware, will help traffic move more efficiently and safely.

12 Winning Another Battle Against Water Pollution—S. M. Parkhill

Some 21 million gallons of sewage are handled daily by two Charlotte, N. C., plants. Tanks aerated by axial-flow compressors spur the process.

20 Monoform—Peter Sleight

Three nozzles simultaneously apply this roofing. Two spray on asphalt; the other, glass reinforcing.

22 True-Turning Towboats

Modified air hoists give *Samson* and *Enterprise* sure steering for close work in the Gulf area.

23 On His Birthday

Gabriel Fahrenheit, the German physicist who gave us a thermometer scale, was born 275 years ago.

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By placing a load cell under each leg of a tank, what's inside can be measured automatically.

25 Soil Density Checks Made Easy

All you do is dig a hole and fill it with a balloon.

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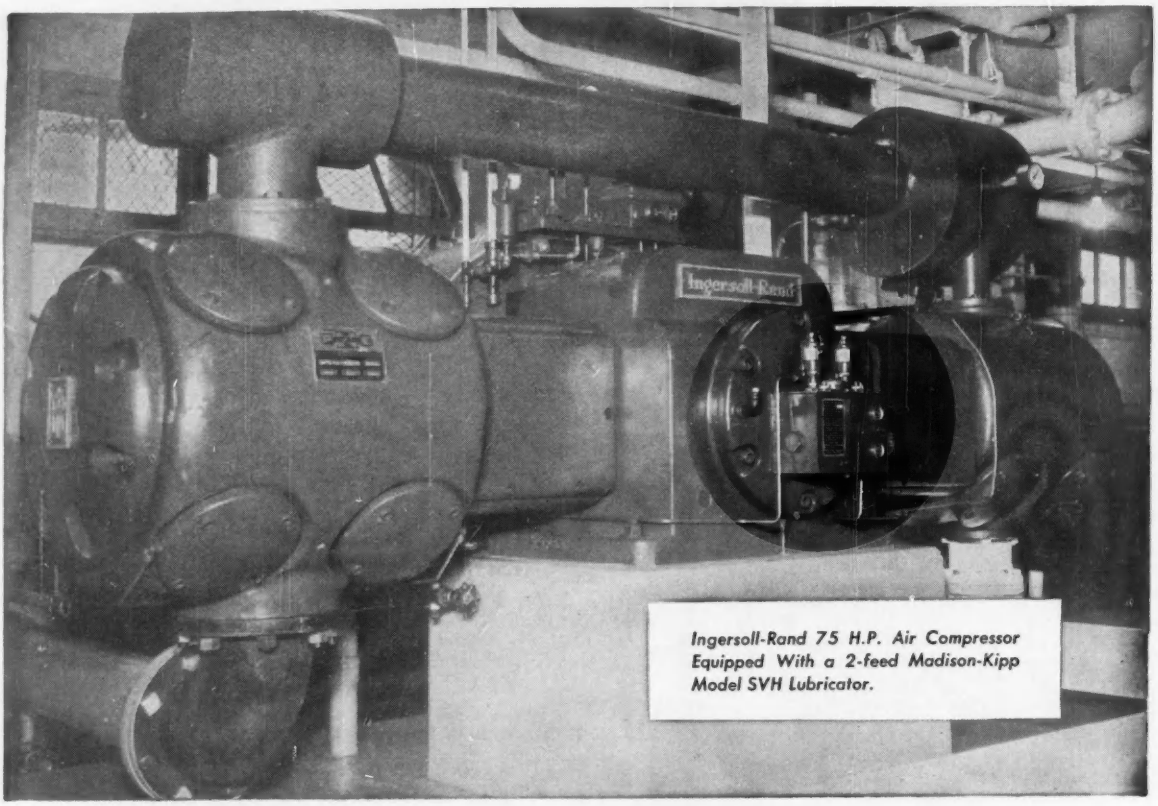

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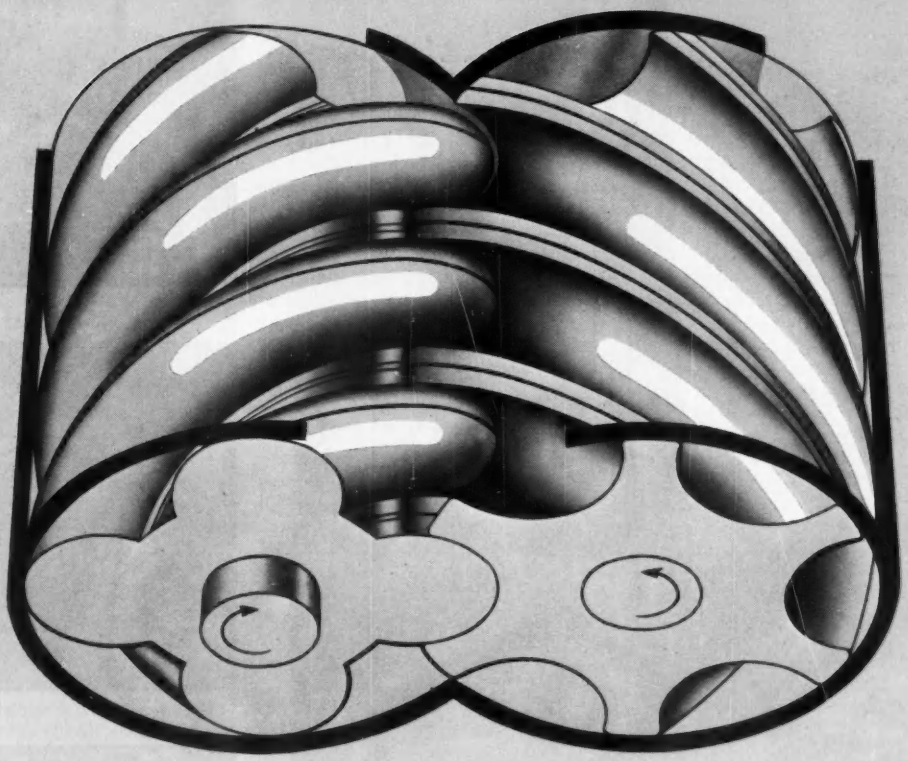

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Blasting Away A Bottleneck

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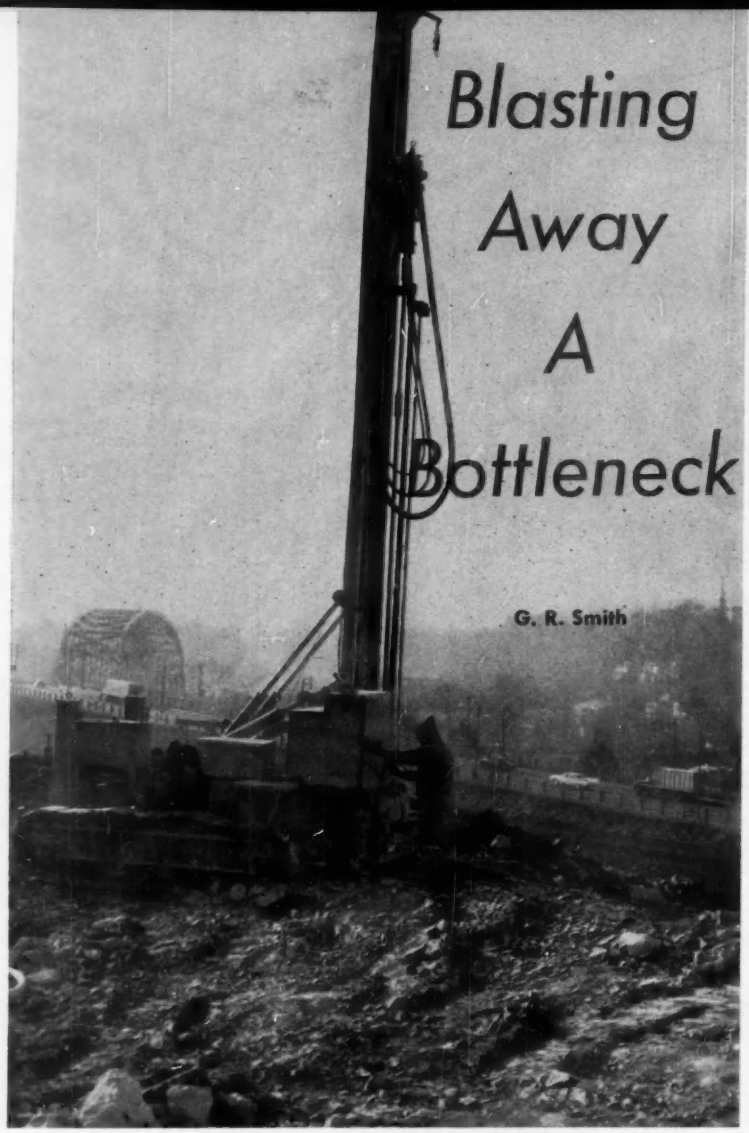
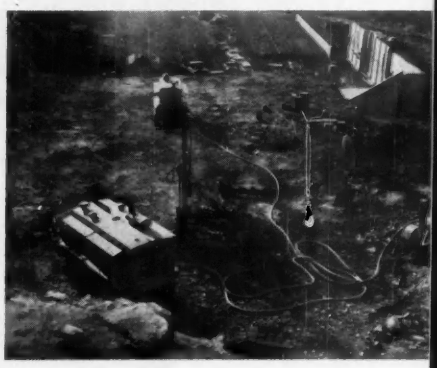




DRILLING Immediately above an Ingersoll-Rand Crawlmaster drill puts down a blast hole; bridge and existing approach are in background. The three smaller pictures show Crawl-IR's and Crawlmaster about the project, drilling more blast holes in the worksite's limestone. Air is supplied by 600 and 900 cfm Gyro-Flo compressors. In bottom photo, existing toll plaza is visible.

AN important and often picturesque artery leading from Midwestern United States into the East, and New York City, is U. S. Route 22. It originates in Cincinnati, Ohio, at the far southwestern corner of the state where the rolling countryside of Indiana and Kentucky are close at hand. From Cincinnati, the highway immediately sets its dominant direction: it strikes northeast toward Pittsburgh and the Monongahela River some 250 miles distant.

As it passes the Steel City, it heads more easterly now and, pressing on, weaves through the hazy blue heights of the northern Alleghenies into Pennsylvania's beautiful Mifflin County. Next, it angles southward for a time until it meets its more powerful rival, the Pennsylvania Turnpike, at Harrisburg, Pa. Here Route 22 vaults the Susquehanna and suddenly becomes more businesslike. Its two lanes grow to four. Its curves straighten and its grades become less severe. The highway proceeds northeast again and sprints for 100 miles to the Lehigh River Valley and Allentown, Bethlehem and Easton, Pa. To the north stands the first dark ridge of the Pocono Mountains.

At Easton the highway spans the historic Delaware River, enters Phillipsburg, N. J., then shoots across the 70-mile breadth of New Jersey to Newark, just short of New York.

There are several sites of possible severe congestion along the 600-mile length of the highway, certainly at Pittsburgh or Harrisburg, where even a few minutes of slowed traffic can create a nasty snarl. But perhaps the point with the highest potential is Bushkill Street Bridge where Route 22 leaves Pennsylvania and passes over the Delaware to enter Phillipsburg and New Jersey. Besides the respectable traffic created by the 100,000 persons that make up the industrial Lehigh Valley, the bridge is a favorite for commercial transportation heading to and from New York City. Every day and night, hundreds of trucks from Pennsylvania and farther west funnel onto Route 22 and thunder into the city. They carry products ranging from structural steel to lingerie—finished goods that will be sold to the metropolitan area's millions and raw materials that will be reworked and shipped to customers across the country.

When the weather is normal the stream of trucks and cars passing over Bushkill Street Bridge proceeds smoothly though continuously. During extremes of weather, the situation changes. For example each time last winter when a new blanket of snow fell on the area, the traffic piled up magnificently behind both entrances to the bridge toll plaza. Route 22 became a snake line of snarled cars and trucks. For 4 miles, travel was often faster by foot.

In the summer there is no trouble with the road surface but the peaks in traffic volume create a problem. When the temperature hits the 80's and 90's and coincides with the arrival of a weekend, a vast exodus begins from New York City and its environs. The sweating inhabitants scatter to temporarily avoid the hot concrete. A percentage of these millions head for the cool green mountains of Pennsylvania and of these, many take Route 22 directly out of New York to the west. Though there are three westbound toll lanes handling traffic at Phillipsburg, often they are not enough. Occasionally New York or New Jersey citizens find themselves staring at a miniature version of the ghastly tie-ups found at the Lincoln or Holland tunnels. Many of the perspiring drivers had just fought their way through these tunnels 2 hours earlier.

In order to relieve the congestion and the threat of more to come (for the traffic across the bridge is increasing by about 10 percent each year), the New Jersey Highway Department and the Delaware River Joint Toll Bridge Commission are spending over $3,000,000 in building a new bridge approach and toll plaza. The Department will contribute $900,000 and the Commission, $2,200,000. As can be seen from the accompanying drawing, the project essentially calls for straightening and widening the approach to the bridge and providing additional and more modern toll booths on the New Jersey side. The new approach will have a grade of 5 percent while the present one has a 6.5 percent rise. This will be accomplished by raising the new roadway an average of about 30 feet above the old one, thereby eliminating the existing dip down to the toll plaza.

Excavation on the project began in September 1960 and is expected to be finished sometime this spring. The whole job will probably be done in November of this year, some 4 months ahead of schedule. About 85,000 cubic yards of rock and 35,000 yards of earth are being moved by J. H. Beers, Inc., Richmond, Pa., under the prime contract awarded to Public Constructors, Inc., Blackwood, N. J. All of the excavation material plus an additional 140,000 cubic yards of borrow are being used to raise the level of the new approach.

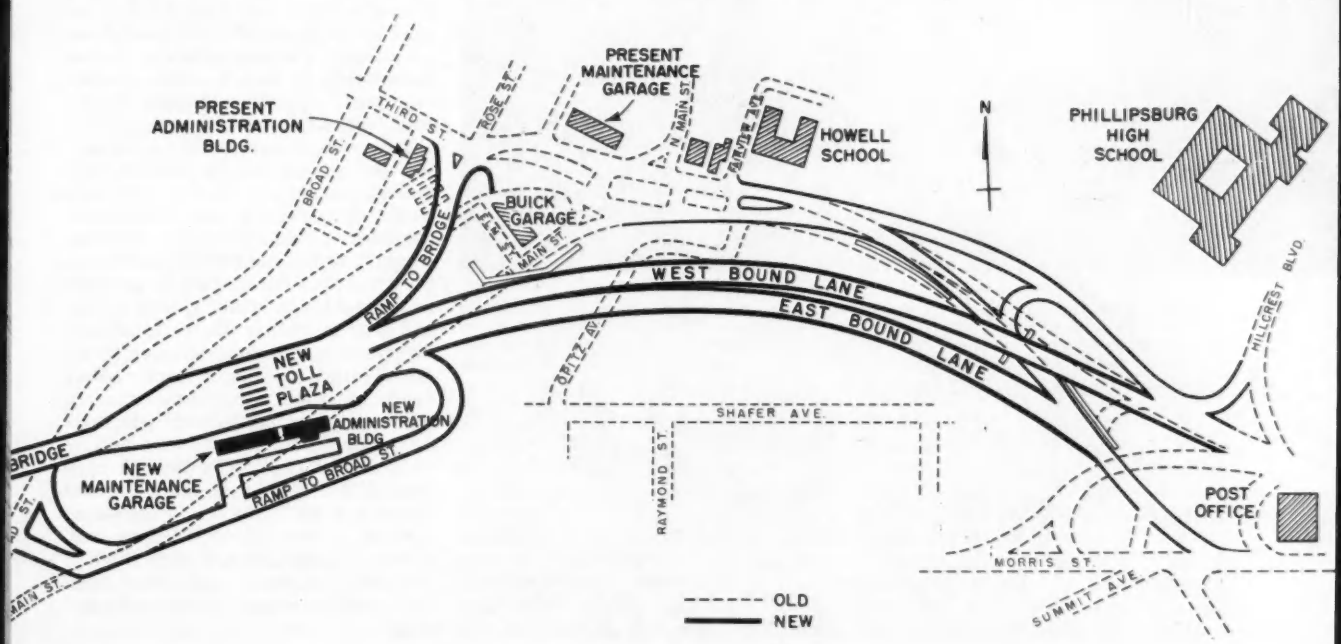
Although forced to shut down from December 11 to the end of February, Beers has completed the main cut, a 60 x 800-foot gash of rock generally paralleling the old approach and lying to the south of it. This incision contained about 50,000 cubic yards of material. A small cut of 20,000 yards for a new local roadway ramp is also finished. Two other cuts on the main route, totaling about 50,000 yards, are well along. To put down his blast holes, the subcontractor has used Ingersoll-Rand track-mounted Crawl-IR drills as well as the new and larger Crawlmaster drilling machines. Several different patterns have been used with hole spacings of 8 x 8 and 10 x 10 feet.

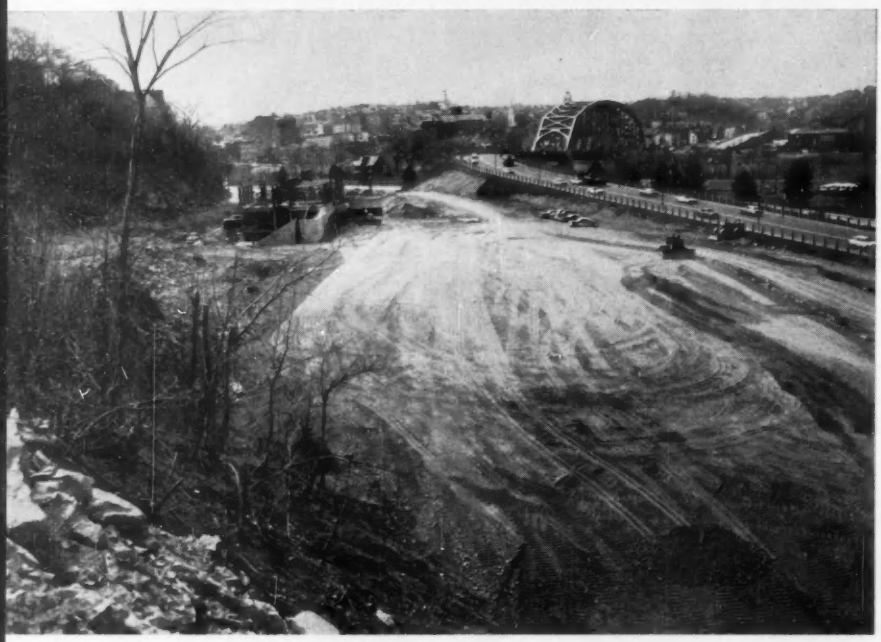
Rock at the site is limestone and the contractor has used 3-inch bits on the Crawl-IR machines and 4-inch on the Crawlmaster. Lifts have averaged from 18 to 20 feet. Hercules gelatin dynamite and Hercol, and Atlas Gianite, have been shot with delays varying from 1 to 20 milliseconds. Electric priming fired all blasts except at one retaining wall cut where Primacord was used. Because the worksite is near a residential area, seismographic control has been provided.

Some drilling work on the project has also been done by a special Ingersoll-Rand unit mounted on a tractor rig. The machine carried two Hydra-Booms, hydraulic drilling arms capable of movement in a wide arc about the working area. This unit mounted its own Ingersoll-Rand Gyro-Flo portable rotary air compressor. The Crawl-IR's and Crawlmaster machines on the job were also fed air from Gyro-Flo compressors, 600 cfm units on the former and a 900 on the latter.

In addition to drilling equipment, Beers has had on the project two Northwest 80-D 2¼-yard-capacity shovels, a Northwest 1-yard backhoe, as many as five 12-yard backdump Euc's, and compaction equipment.

The prime contractor's main job is building two new 3-lane roadways. Both are about 3000 feet long with the eastbound lane averaging 35 feet in width and the westbound, 38 feet. The 9-inch concrete course for these will cover about 25,000 square yards of area. Two local roads, feeding into what will be the more highly traveled main route, will be surfaced with 18,000 square yards of as-





CUT AND FILL Northwest shovel in top photo loads earth into Euc for haulage to lower level of site. Crawl-IR works in background. The other illustration shows bridge, and large fill area in foreground. New lanes will come toward camera and pass out of right part of picture. Foundation of administration building rises, left center.

phalt, also 9 inches thick. Other work includes an 80-foot-span steel and concrete overpass; a 40-foot-high retaining wall to be erected between the new roadway and an existing automobile agency building; a second retaining wall that forms the foundation for a new combination administration-garage structure; guardrails for the new roadways; and necessary landscaping and drainage.

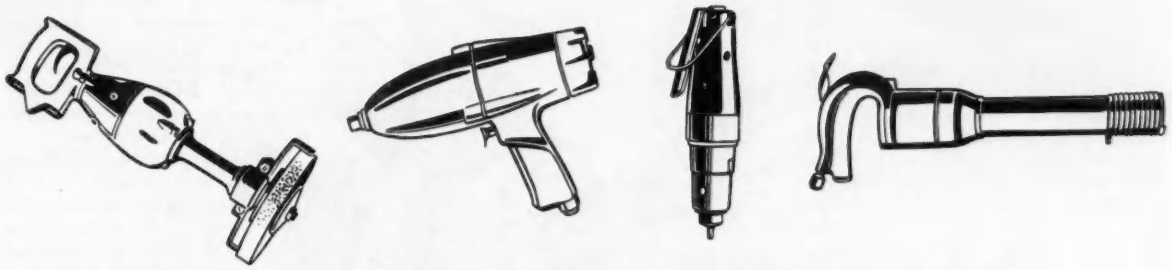
Work on the project during the winter was slowed by two main factors. First, because traffic had to pass over the bridge nearby, detours were impossible, and some of Route 22's lanes had to be free at all times. Two of the three westbound lanes and one eastbound lane were kept open. (This provision was required in the contract.) Second, the worst winter in 35 years dropped 68 inches of snow on the worksite. Temperatures in December and January averaged 7 degrees below normal. In each month of December, January and February a blizzard left more than 10 inches of snow standing on the construction site. When the contractor's workmen were able to get to the job, they were often faced with zero temperatures. It was during this period that the substructure was put in for the 80-foot-span overpass on the westbound lane. Using air from an Ingersoll-Rand 900-cfm portable Gyro-Flo compressor, Public Constructors drove some 4700 feet of pipe piles for cast-in-place concrete piling. A Lima 803 piledriver and a Vulcan No. 1 hammer were used.

Of the $3,000,000 being spent on the new plaza, Public Constructors' contract for $1,887,499.89 is the largest parcel, but a good portion of the cost will go toward putting up new toll booths and two new buildings. The new administration structure and new garage for the bridge-maintenance equipment will be erected end-to-end. A local builder, George Coopersmith, has a $348,415 contract for these. Shoup Electronics Company, Philadelphia, Pa., won the bid for the toll booths, which will cost $238,500. Seven modern booths will replace the six old units that have been used for 21 years. (There will be eight lanes—the middle booth will handle two.) Improved electronic toll recording equipment will be installed.

The new plaza will be able to handle more traffic and be better equipped to meet peak traffic loads. All tolls will be received from the driver's side of the auto—experience has shown that most drivers would rather wait in line for several cars than take the trouble to pay through the passenger-side window. Should vehicle intensity take a sudden rise, plaza personnel will be able to open five of the eight lanes in one direction.

Two other advantages have been built into the new installation. One is that the improved plaza will reduce the possibility of runaway vehicles. Such out-of-control cars and trucks are a special danger now because both the bridge approach and the bridge itself slope down to the toll-booth area. A wild vehicle will head for the booths, the location of highest traffic concentration. (Westbound drivers also now must make a nearly blind left turn just before entering the toll area; this will be eliminated.)

The second advantage is that, because of its 30-foot rise in elevation, the new plaza will be above flood level. Citizens in the area are highly flood conscious as a result of the Delaware River's rampages. A particularly violent flood in 1955 sent the waters out of the banks and completely engulfed the toll plaza area.



PERIODIC PREVENTIVE MAINTENANCE

V. *Vane-type Pneumatic Tools*

VANE-TYPE pneumatic tools may be divided into three groups: drills and motors; grinders; and screwdrivers. Impact wrenches are also classed as vane-motor tools. Like other air-operated tools discussed in this section during the past 4 months, vane-type tools receive sound engineering, for it is obvious to tool manufacturers that they will be neglected to some extent and will see rigorous service.

However, routine maintenance is of keen importance if the advantages of engineering and the tools themselves are to be fully realized. Their good performance can be assured if three points are checked periodically: that (1) there is an unrestricted flow of air at the recommended pressure; (2) that the exhaust system is functioning correctly; and (3) that matching parts are within accepted tolerances. These are the three basic areas that should be covered in programs of periodic preventive maintenance.

Throttle controls on drills, motors and screwdrivers must be checked periodically. Troubles arising from worn, broken or missing parts in this area can lead directly to inefficient operation—another way of saying wasted work dollars.

As the name implies, the vanes are the heart of the tool. As a result of centrifugal force, they are constantly sliding in and out of a floating fit. This, together with inherent rotary motion and vibration of the tool increases the possibility of wear. The leading edge of each vane must be in excellent condition if the vane is to seal the air properly. Foreign material entering vane-type air-operated tools tends to cling to the vanes; the leading edges wear from abrasion; the air seal is broken, and the tool is inefficient. Therefore filters in the line and strainers are vital if these contaminents are to be kept out of the tool. The proper filter for the air system's conditions should be selected, as described in the first article of this series.

Even though vanes are carefully engineered, scientifically shaped, and fabricated of any number of materials, they are very inexpensive to replace. There is no excuse for not renewing them whenever signs of wear appear. This assumes, of course, a well-organized program of periodic preventive maintenance.

Those vanes that are obviously loose should also be replaced to maintain the efficiency of the tools. When they are worn thin, they should be removed and new ones inserted, for a broken vane might wedge part of itself between the rotor and cylinder.

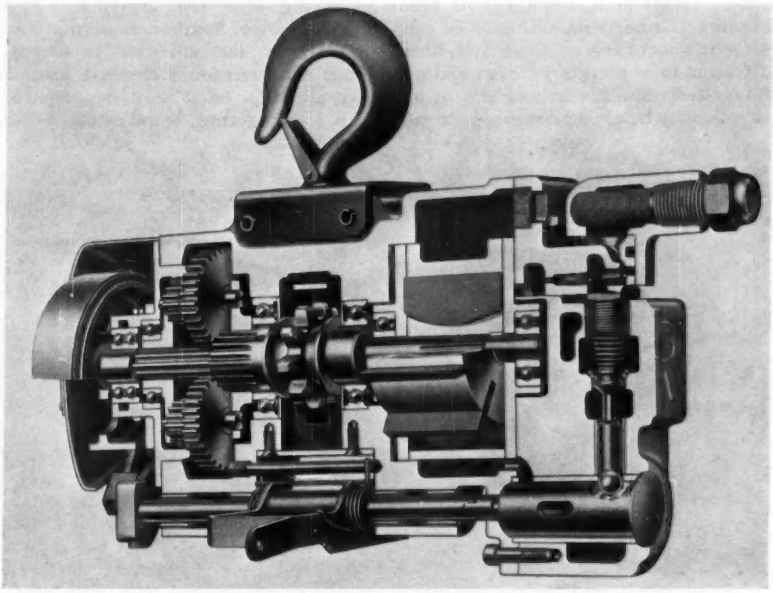
When the cylinder or roter is damaged it is an expensive repair and a new tool is indicated.

Screwdrivers

Screwdrivers operate at constant high speeds. Without proper lubrication, burning, setting of bearings and excessive wear of the screwdriver will be noticed. This will lead first to a reduction of performance and eventually to failure of the unit.

In quality screwdrivers, it is easy to remove the driver from the gear case for periodic inspections. At the same time, the clutch assembly can be removed as a unit for greasing.

When lubricating screwdrivers, any vane tool, or indeed, any air-operated tool, the manufacturer's instructions should be followed. No tool is shipped from a reputable manufacturer that does not contain a set of instructions. Too often these are misplaced in unpacking or do not reach the hands of the men responsible for periodic lube jobs. This practice is not consistant with any program of planned maintenance and



HOIST Lubrication is essential to proper hoist operation and long service life, whether a Multi-Vane air motor hoist as illustrated or a piston-type model discussed in the preceding article. Gears must rotate in a bath of grease. The built-in oil chamber must contain lube for constant and regulated lubrication of the motor.

should be stopped as quickly as possible. Everyone should be made aware of the importance of proper, clean lubrication and the manufacturer's instruction sheets and parts list should be kept in good, readable condition, or replaced.

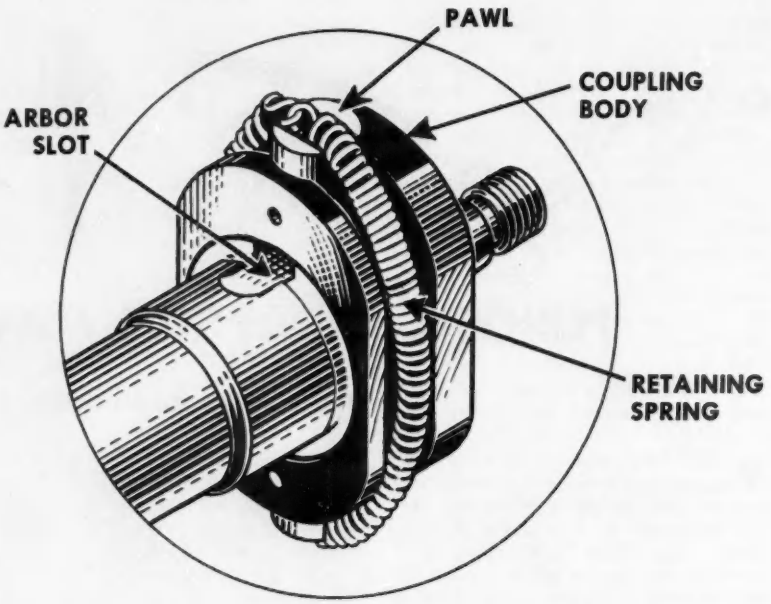
Daily lubrication is equally important. It should be made by means of air line oilers, adjusted to the proper feed rate as described in the first article of this series. The proper grade of lubricant must always be used too, and oilers must not be permitted to become dry.

Filters in the air system trap particles of rust, dirt and scale that may be entrained in the air. Their elements must be replaced or cleaned regularly, depending on the type of filter used. One method that is practical to take care of lubricators and filters is to assign janitors who normally work around the machine areas the task of checking these air system aids.

Grinders

Special care must be given grinders. A program of periodic maintenance to keep the tools on the line as long, as safely, and as efficiently as possible is essential. Broken tools, lost man-hours and inefficient tools contribute to high operation costs. The basic considerations of tool efficiency and service that have been discussed throughout these articles hold true for grinders, and safety deserves special considerations.

A well-devised program of *frequent* periodic maintenance and inspection of grinders can alleviate potential unsafety. The arbor should be inspected to determine whether or not it is bent. Wheel flanges must match and be kept in pairs. Grinders should never be run without wheel flanges. Dents and other defects in these must be guarded against. Bolts, washers, retainers and clamps on guards must be checked regularly to see that they are tight and in good operating condition.



OVERSPEED SAFETY COUPLING If the grinder reaches a speed slightly higher than the designed operating speed, centrifugal force acting on the pawls (see enlargement above) causes them to overcome the tension in the retaining springs and fly outward. This disengages the arbor, immediately slowing down the grinding wheel and then stopping it. The retaining spring must be inspected to see that it is of the proper tension for safe grinding operations.

Governors

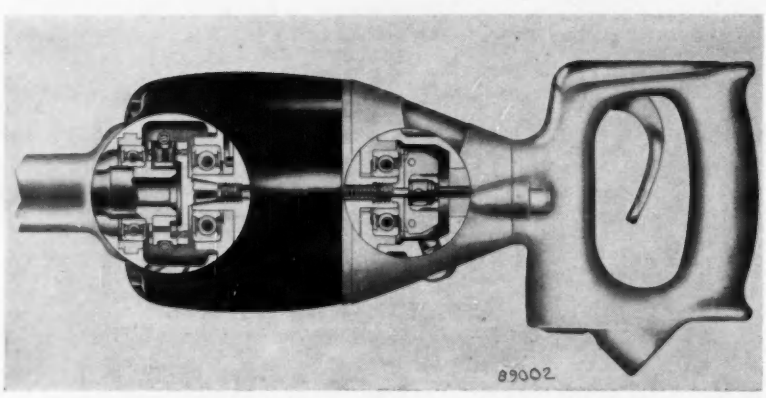
The governor is directly responsible for the speed of a grinder and deserves considerable attention. In reliably manufactured grinders, very little can go wrong with the governor. The governor valve, however, must function properly or the governor is useless. When the governor is changed, critical spring tension on it must be watched. This correct setting is indicated by the tool manufacturer and should be verified by checking the grinders on a tachometer. Too light a setting is safe, of course, but the grinder will never reach peak performance. Too tight a setting leads to overspeeding. An operator who believes he has the right grinding wheel for the speed at which the grinder should be turning, may find that the wheel is spinning faster. The grinding wheel may then burst. Wheels are rated for specific rpm's by their manufacturers, and the rpm is regulated by the governor. There is no gearing.

Wheels that have been dropped may be chipped or cracked and should be destroyed. They too could fly apart. It is recommended that wheels be stored on wooden pegs on a wall—not in a box or bin.

If erratic speed is noted in the action of the grinder, it is probably due to foreign matter preventing free movement of the governor valve. The governor valve cap should be removed and the cavity blown out with compressed air. Valve bushings that might wear can be inspected at the same time. If need be, they can be replaced inexpensively.

A grinder should never be run without retesting after the governor has been repaired or replaced. It must be checked with a tachometer. Even when the governor is operating correctly and has not been removed, it is best to inspect the tool frequently with this device.

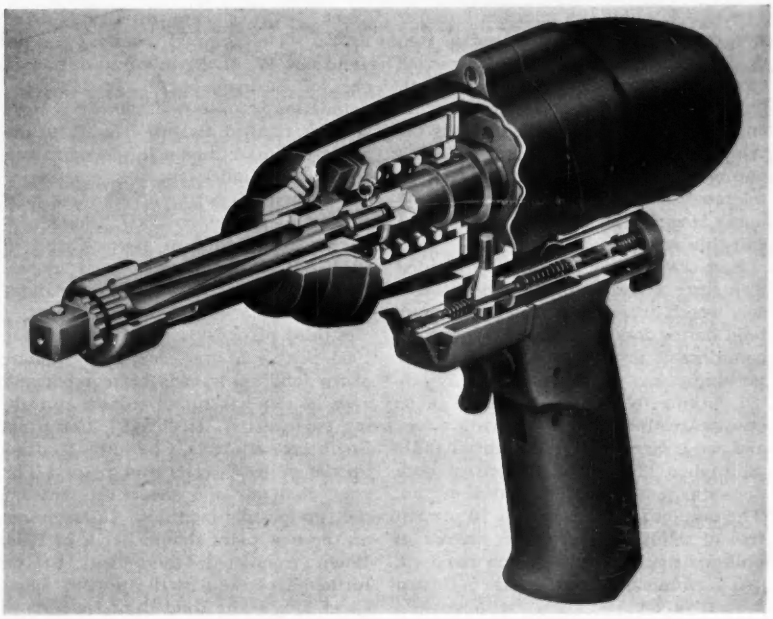
As an added safety feature, some high-quality radial grinders have a special



GOVERNOR Shown at the back end of this Ingersoll-Rand Size 4 grinder is the factory-set weight-type governor which maintains the proper operating speed while grinding. If the governor becomes inoperative because of dirt, wear, abuse or maladjustment, the Overspeed Safety Coupling comes into operation. It is shown to the left of the governor in this cutaway.

disengaging clutch in addition to the governor. Two pins engaging the arbor and drive shaft are held in position with a calibrated spring. If overspeed occurs, the pins overcome spring tension and fly out from centrifugal force disengaging the arbor. In maintaining this clutch mechanism, milled slots in the arbor that hold the pins must be checked for wear. In replacing springs, ones of correct size and tension must be used. This can be determined from reading the very important manufacturer's parts and instruction lists.

As an added safety check on malfunctioning governor valves, some surface grinders have a modification of the governor. By centrifugal force, an additional spring in the governor allows safety weights to trip the governor valve. This shuts off the compressed air supply. To reset the governor lever, it is necessary to remove the backhead. When this is off, it is a simple matter to check the governor valve for cleanliness and proper function.



TORQUE CONTROL Those Impactools equipped with a Torsion Bar Torque Control must be inspected for cleanliness and free valve action. It is this that stops the tool when the predetermined torque is reached. Without this action, excessive wear of expensive parts will result.

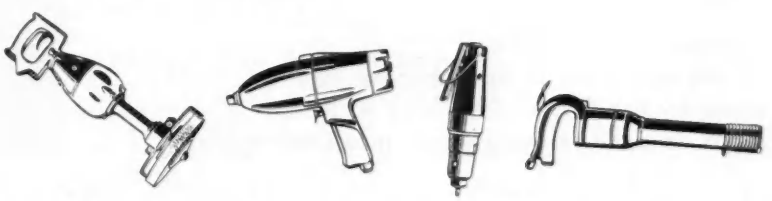
Impact Wrenches

In impacting tools, rotary motion is translated into impacting motion. Consequently, the tools must be rugged and quality tools are. The greatest contributor to complete tool failure is improper, insufficient or dirty lubrication. Lubrication prevents seizing and binding of such parts as the impacting unit. All the positive statements expressed time and again for air line lubricators and filters are especially applicable here.

The tool sales-engineer should be questioned as to points of wear that can be inexpensively replaced in a program of routine maintenance. An excellent example are planet gears which wear naturally and are inexpensively renewed. Care should also be exercised to see that the tool is not misused. Misapplication can cause interference of the normal tool design; excessive rebounding from work can cause major wear.

In torque controlled impact wrenches, maintenance often centers around the torque control valve that is responsible for shutting off the air supply to stop the tool. It operates on reaction of a torsion bar. (The torsion bar itself is not subject to breakage for it is a spring, but it can be stretched beyond its elastic limits.) Wear or dirt in the trip valve mechanism will cause improper reaction. The torque control spring must be kept in critical balance at all times for proper functioning; when it becomes worn or stretched, it should be replaced at once.

—*S.M.P.*



Summary

All pneumatic tools—percussive, piston and vane-type—are carefully engineered to perform the service for which they are intended. Metallurgy and engineering technology has improved through the years so that tools today are made of the toughest materials available, though they are of the lightest weight per horsepower output possible. Precision made for rigorous work, air-operated tools are one of industry's best buys.

Yet, without a proper system of planned, periodic preventive maintenance, pneumatic tools can be a short-lived, "expensive" item in a budget. With proper care they are economical instruments of air power; without proper care and replacement of worn inexpensive parts, they can sabotage an air-power budget.

There are six reasons for premature failure of pneumatic tools. Two of these lie in the air system—excess moisture in the air, and dirt, rust and scale from old hose and piping systems. Manual abuse and misuse of tools is the third culprit. Clogged air strainers at inlet ports decreases working efficiency; failure to replace them after cleaning may lead to destruction of motors and other moving parts. Improper, dirty or insufficient lubrication can be equally disastrous. The final reason is, of course, failure to replace inexpensive parts that have worn. This leads to progressive fatigue failure of tools and repair bills that may well exceed 40 percent of the original tool's cost. When this figure is passed, it is well to replace the entire tool. However, these replacements should not follow a random pattern due to neglect of planned preventive maintenance, but should be integrated into a program of planned annual retooling.

Above all, it must be remembered that pneumatic tools, and the compressors from which they derive their air power, are only a means to an end.

As stated in the second article of this series, and as implied throughout, the real goals of a planned preventive maintenance program are to increase efficiency and cut costs.

Winning another Battle Against Water Pollution

S. M. Parkhill

FOR CENTURIES man has found it convenient to dump his sewage into streams and rivers to be carried away and purified by nature. With populations thickening and the attendant growth of water uses, there is developing an alarming shortage. Such natural "treatment" can no longer be tolerated; water needlessly polluted by man's laziness squanders one of our most valuable resources.

Raw sewage may be generally divided into three classifications: domestic sewage, which includes human and household wastes; industrial wastes, which vary considerably in both type and degree of pollution; and storm wastes.

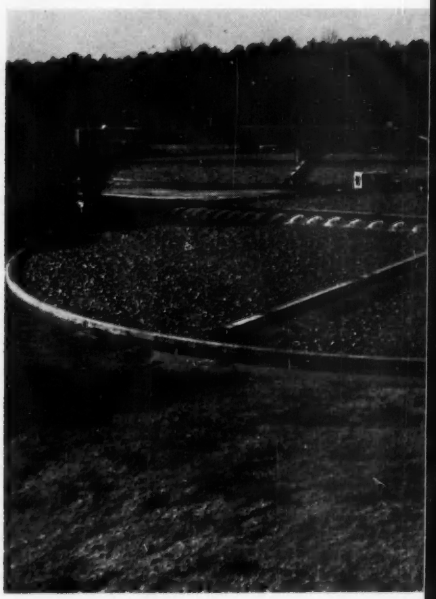
Charlotte, N. C., can be proud of its sewage treatment works at Irwin Creek and Sugar Creek. Together they handle daily about 21 million gallons of both domestic sewage and industrial wastes. The outflow is approximately 90 percent free of solids and has 94–96 percent of polluted materials in solution removed. (As is customary, storm sewage is treated separately and will not be discussed.) The Sugar Creek plant is currently undergoing expansion; when completed, the combined rated capacity will be nearly 26 million gallons per day.

Growth

Like most cities, Charlotte has grown steadily. The Sugar Creek and Irwin Creek facilities were installed in the 1920's. The original plants were designed by W. M. Piatt, consulting engineer of Durham, N. C. In 1930, the population was about 80,000. Ten years later, it reached 100,000. By 1950, the figure was more than a third larger, and both plants underwent a second major enlargement. (Sugar Creek was previously expanded in 1927; sludge digesters were added at Irwin Creek in 1947.) The population served by the combined operations today is about 200,000.

A third plant is proposed south of the 1960 perimeter area (*see map*). Some of the land has already been purchased, and the city has authorized the consulting engineers, J. N. Pease & Company, Engineers-Architects, Charlotte, to draw up the necessary data and plans. The same company was the consultant for the two existing facilities. Construction on the new plant should begin in 1963. When completed, there will be no further expansion at the present Sugar Creek site. The total drainage area of the three works will total more than 136,000 acres—nearly double the present acreage.

The role of the consulting engineer is vital in preparing basic and future-expansion plans of sewage treatment plants. When authorized, the engineer must first gather a variety of statistical data and pollution strength characteristics for the area. He evaluates these and determines the best type of treatment process that will effect pollution control in accordance with local and federal laws. In this case, the State Stream Sanitation Committee, Division of Streams Sanitation & Hydrology, North Carolina Department of Water Resources, has made a survey of the major drainage areas in the state. It has classified them and is in the process of drafting public laws regulating the limits of pollution allowable for downstream needs. This is major progress when one considers that not long ago it seemed satisfactory to simply get rid of our sewage and wastes in the most convenient water course. The work in North Carolina is typical of that going on in many states. Taken together, it amounts to a giant factor in controlling our water resources. Once these data are established, the consultants can de-



Compressed air is vital in the activated sludge process used by the City of Charlotte to treat both domestic sewage and industrial wastes

sign the plant to handle effectively anticipated loads.

Processing

Biologically sewage contains saprophytic bacteria and other complex living microscopic organisms. The bacteria are important for they feed on the dead organic matter, decomposing it. Stable compounds result. Like other living matter, the bacteria need oxygen. Certain species can absorb oxygen only when it is dissolved, that is, free or molecular oxygen. These are the aerobic bacteria. The process of degradation of organic solids which they perform is called aerobic decomposition, oxidation or decay. It does not produce a foul smell and it is not unsightly.

Moisture is also required by saprophytic bacteria. This is more than provided by the watery sewage. Temperature too must be favorable for peak efficiency.

Both plants in Charlotte use the same method of treatment based on this biological action. The only difference between them is in layout, because of the terrain. Equipment is the same, too. Variations in operating data are shown in an accompanying table. The following discussion is based on the Irwin Creek operation except where indicated.

Sewage processing at Irwin falls into three phases: preliminary, primary and secondary treatments. The sewage flow never stops, but continues its journey from beginning to end, at times fast, at times slow, taking in all about 10 hours. As the word implies, preliminary treatment consists of getting the sewage ready for working. During primary treatment, inflow is measured and the liquid passes through the first settling tanks. Resulting sludge is sent to digesters. By far the most extensive treatment is the third. It is here that compressed air plays its major role and that the so-called activated sludge process is applied.

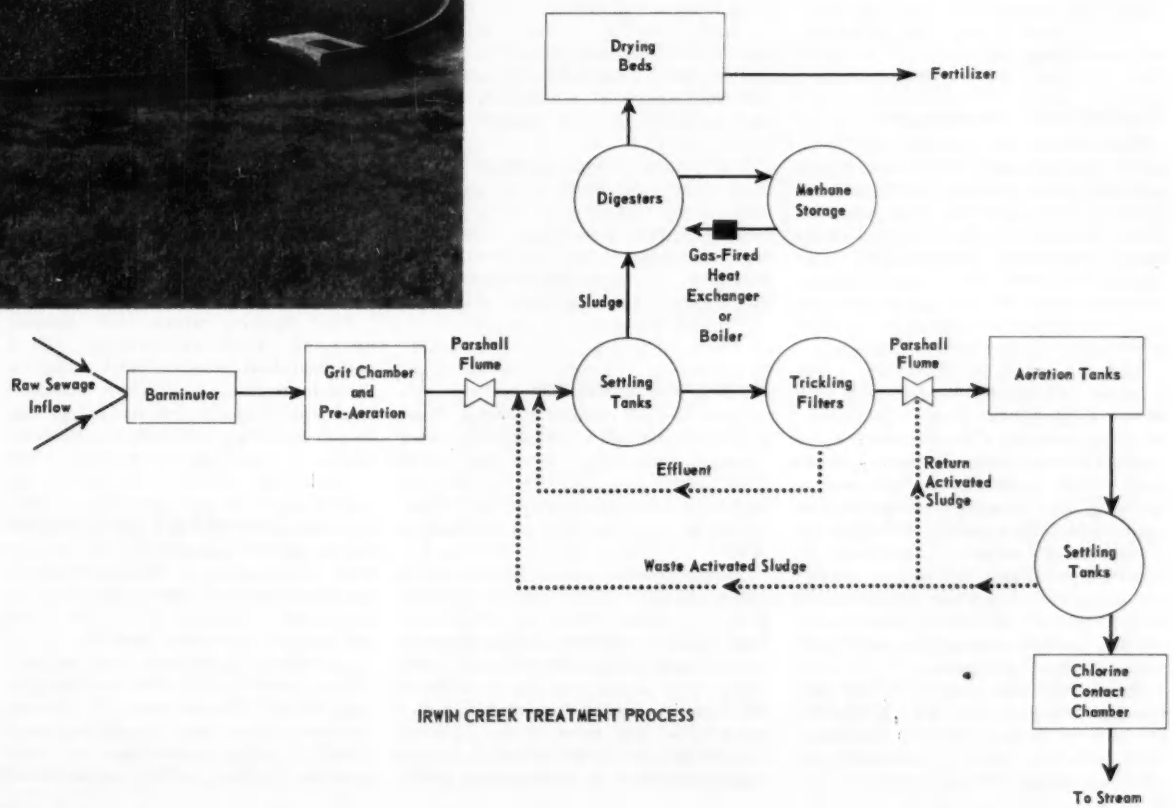
Activated Sludge

This process was discovered in 1913, and 3 years later was in successful operation. Sewage must be well aerated throughout if putrefaction is not to occur. Basically this is how it works:

Suspended matter gradually disappears as the aerobic bacteria go to work. A granular brown mass of living organisms, bacteria and protoza forms and settles quickly. Inorganic salts (chlorides, nitrates, etc.) are contained in the clear, top liquor.

Drawing off this mass and adding it to raw inflowing sewage reseeds the influent. It supplements the bacteria and other organisms nature has already pro-

ROUGH FILTERS High-rate trickling filters (left) aerate the sewage by natural means. The distributor arms constantly swing about, sloughing off the stones and keeping filter flies from hatching. Solids in suspension are caught by the stones and are turned into working bacteria by nature. These units back up the statement that the Irwin Creek (illustrated) and Sugar Creek installations are for complete sewage treatment. From the trickling filters, the flow is again measured in a Parshall Flume before it goes to the aeration tanks. The entire process is diagrammed below.



IRWIN CREEK TREATMENT PROCESS

AXI-COMPRESSORS At Irwin Creek, there are five Ingersoll-Rand Axi-compressors, supplying a total of 20,725 cfm of air for the treatment works. Pressure is 6.4 psig. The unit at the far left is driven by a 200-hp Reliance induction motor. It is rated at 5000 cfm. All others are direct-connected to General-Electric Tri-Clad, induction, 60-cycle, 440-v, 200-hp motors. The Axi-compressor in the foreground is rated at 5225 cfm; the unit to its right, 4300 cfm; and behind these, 3100 cfm each. All were furnished by Chicago Pump Company as a part of a complete sewage treatment package.

vided. Agitating the whole mixture with compressed air to keep it in suspension and provide free oxygen for the bacteria quickens the oxidation. The activated sludge, by means of its living organisms feeding on the dissolved and suspended solids, reduces the suspension to insoluble nonputrescible solids. Each succeeding cycle produces additional solids. Eventually the optimum concentration of solids (the "activated sludge") is reached. Then excess sludge is sent to digesters, as will be shown, and only a part is used for reseeding incoming sewage. With this process, oxidation can be completed in a few hours.

At the time of their initial construction, Charlotte's plants were two of few in operation in the U. S. applying activated sludge. The total using the process could be counted on your two hands. Today, of the facilities handling comparable sewage, about a third utilize the activated sludge method.

Preliminary Treatment

Raw sewage is fed into the Irwin Creek Plant from two lines. It is turbid and of a mousey color. Suspended solids make up 173 parts per million. This inflow passes through a Chicago Pump Barminutor which chops up the large organic material and inorganic matter that might later damage pumping equipment. It prepares the sewage and makes subsequent treatment more efficient.

The influent then passes into a grit chamber, a large rectangular tank with baffles to guide the flow. Compressed air is fed into the sewage through openings a few feet above the bottom of the tank. It is admitted at a pressure of 6.1 psig, fast enough so suspended organic solids are passed through, but slowly enough so sand, gravel and the like, which always accompany sewage, are dropped beneath the aeration zone. Should grit get through, it would score moving parts of pumps, plug outlets and otherwise foul operations.

Pre-aeration also removes a large percentage of grease and oils. It freshens the sewage before its slow movement through primary settling tanks, and provides an initial BOD reduction.

AERATION TANKS The activated sludge process depends on constant supplies of oxygen for the biological action. This view is looking toward the outflow end of the tanks. The water spray is drawn from the outflow from the high-rate filters and is used to keep down foam that tends to form in this process. In the background can be seen the compressor house, center, and to its right the methane gas storage sphere.

BOD stands for biochemical oxygen demand—that is, the amout of oxygen required to sustain aerobic bacteria. Throughout the process, however, the amount of bacteria must necessarily decrease as the waste is digested and there is no longer food on which the bacteria can feed. The demand for oxygen therefore becomes less and less. Thus, BOD is a standard measure of the efficiency and effectiveness of a sewage treatment works, as determined by routine laboratory tests.

For example, average BOD of the influent at Irwin Creek is 206 parts per million; the effluent is only 7 parts per million—a 5-day reduction of 96.6 percent. At Sugar Creek, the BOD reduction is 94.2 percent. Suspended solids, as expected, are similarly reduced by 90.8 and 89.8 percent, respectively.

Primary Treatment

From the grit chamber, sewage flows by gravity through a Parshall Flume for measurement to the first settling tanks. These tanks are 125 feet in diameter and have a maximum depth of 9 feet. Intake is at the center, outflow at the rim.

Sewage remains here approximately 2 hours, during which time solids settle from the liquor. This is the primary function of the tanks; aerobic digestion is of little concern. Huge scraper arms lazily sweep around, moving the solids to the bottom center of the tank. From this sump they are pumped to digesters. Nearly 50 percent of the solids are removed and from 10 to 20 percent of the oxygen demand is relieved in the settling tanks. Effluent discharged over the rim pours into a wet well to be pumped to the next operation—high-rate trickling filters.

The digesters which have floating roofs are 64 feet in diameter. Their purpose is to remove excess water, reduce the volume of the sludge and convert it into stable compounds. The process may take as long as 1080 hours (45 days) and is accomplished anaerobically. Anaerobic bacteria cannot exist on dissolved oxygen, as do the aerobic bacteria. They depend on the decomposition of organic matter for this oxygen supply. Anaerobic decomposition, or putrefaction, causes a foul odor and is unsightly. In the digestion tanks, of course, the process can neither be seen nor smelled.

It has been found that temperature is critical in controlling the rate of digestion. Rapid changes adversely affect the process too. At Irwin Creek and Sugar Creek, the digesters are kept at a constant temperature with heat furnished

TREATMENT FACILITIES

	Irwin Creek	Sugar Creek	Sugar Creek*
Over-All Capacity			
Rated (mgd)	10	11	15
1960	6	14	...
Primary Settling Tanks			
Number	3	3	4
Capacity each (mgd)	3.3	3.67	3.67
Trickling Filters			
Number	3	3	4
Aeration Tanks			
Number	10	9	11
Aeration Volume (cu. ft.)	623,984	580,230	763,114
Final Clarifiers			
Number	2	3	4
Capacity each (mgd)	5	3.67	3.67
Chlorine Contact Chambers			
Number	1	1	1
Digesters			
Number - Storage	2	0	3
Number - Operating	4	4	4
Drying Beds			
Number	52	73	101
Area (sq. ft.)	208,000	309,516	421,516
Compressors			
Number	5	4†	4
Total Capacity (cfm)	20,725	16,680	16,680

* Expansion completed
† Plus 2 standby units

by boilers. These are fired by a low-purity methane gas given off during the digestion process. Heat exchangers raise the temperature of incoming sludge so there is no shock to matter already in process.

After digestion, the sludge is spread on massive sand drying beds for final purification. Once dried, the stable compound makes excellent fertilizer and is sold for a nominal fee to local residents.

Secondary Treatment

High-rate trickling filters called "roughing filters," the first step after the primary settlers, are 125-foot-diameter tanks filled with 4- to 5-inch stones to a depth of 4.5 feet. These are not always found in activated sludge processes because they are expensive to construct. However, they do help to provide a more complete over-all treatment and are inexpensive to operate.

Effluent from the settling tanks is sprayed over the stones from revolving distributors at an average rate of 465 gallons per square foot per day. This is a constant flow which eliminates hatching filter flies and keeps the rocks sloughed clean. Solids in suspension caught by the rocks are turned into minute green organisms by bacterial action. The rocks develop a mossy slime that acts on the sewage—a variation on the activated sludge process which follows—and eventually sloughs off in the flow of waste waters as suspension in the effluent. (In fact, "biological oxidizing bed" has been suggested as a more accurate name for these trickling filters, but common usage holds on to the other term.) The action in the high-rate filters is one of natural aeration. It helps take the load off the aeration tanks which follow by reducing the oxygen demand.

From the "roughing filters," enough of the effluent is recirculated to the incoming raw sewage to make a ratio of 1:1. This facilitates purification. The balance is passed through a second measuring flume and guided into aeration tanks.

At the flume, activated sludge is added, beginning the process described earlier. It is drawn from the final clarification tanks, which are yet to be described, and amounts to about 25 percent of the volume being fed into the aeration tanks. The color of the sewage becomes markedly dark brown.

It requires 5 to 6 hours for sewage to pass through the aeration tanks. During this time it is constantly circulated with bubbling oxygen. Without compressed air to do this job, action would be slowed to a virtual standstill. Putrefaction and its accompanying foulness would result. Air, and the oxygen it contains, is a *constant* essential.

Aeration

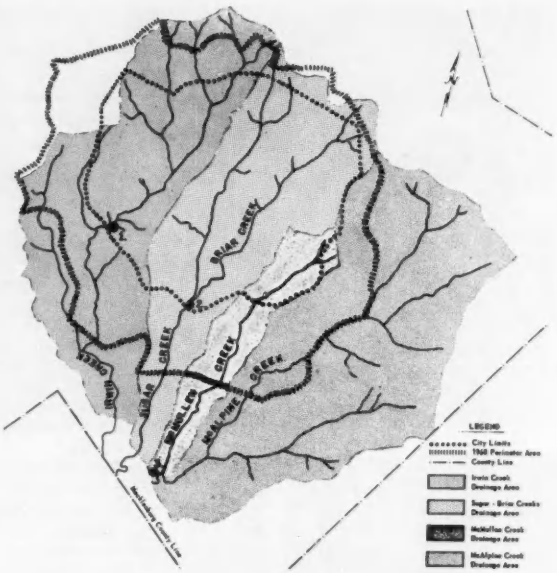
To do the job effectively and efficiently, large-capacity low-pressure units must be selected. These should operate with as little maintenance downtime as possible. They must run 24 hours a day, year in and year out, for sewage treatment is not an 8-to-5 routine.

The aeration system for the Charlotte plants was designed as an integral package by Chicago Pump Company. At both Irwin Creek and Sugar Creek, Ingersoll-Rand Company's rotary Axi-compressors, Type L (low pressure) were specified. Their efficiency is high and maintenance is negligible for a number of reasons, not the least of which is the fact that there is no metal-to-metal con-

OPERATING DATA

(1959–60 Averages)

	Sugar Creek (map fig. 1)	Irwin Creek (map fig. 2)
Daily flow (mgd)	14.653	6.251
Population equivalent (raw)	123,665	61,931
BOD (ppm)		
Influent	173	206
Effluent	10	7
Suspended solids (ppm)		
Influent	197	173
Effluent	20	16
Drainage Area (acres)	30,900	46,500
Total drainage area (acres)	77,400	
With proposed construction (map fig. 3)	136,000	



tact in the air compression chamber.

Important too is the fact that cost of operation is low. Each compressor is direct-connected to a 200-hp induction motor. Power is furnished by Duke Power Company. The 1959–60 average requirement was 422 kwh per million gallons treated at Sugar Creek, and 299 kwh per million gallons at Irwin Creek. Power cost per million gallons treated averaged $3.75 at the former installation, $2.66 at Irwin.

Air requirements in the activated sludge aeration process are governed by four factors: the BOD load; the quality of the activated sludge being treated; the amount of solid concentration; and the desired efficiency of BOD reduction. At the Irwin Creek plant, there are five Axi-compressors. Total rated output is 20,725 cfm. At Sugar Creek, there are four, total capacity 16,680 cfm. The 1959–60-average air consumption, in terms of sewage operation, was 14.013 million cubic feet per day, or 0.97 foot per gallon of sewage treated, at Sugar Creek; and 4.299 million cubic feet per day (0.70 cubic foot per gallon) at Irwin.

A close look at Irwin shows a typical installation. Six aeration tanks were installed by 1927. Four more were added in 1956. These may be thought of as three pairs and two pairs. Running throught the center of each pair is a tapering air line: three 8-inch ones in the older tanks; two 12-inch lines in the newer ones. The large intake ends are connected to 20- and 24-inch lines, respectively, running directly from the compressor building. Air is supplied at a nominal 6.4 psig at both treatment plants, maintained at a constant pressure by the tapered lines.

Attached to these tapering lines are tee's, and to these are connected Swing Diffusers designed and furnished by Chicago Pump Company. The tee's extend into the tanks at intervals that vary from 12 to 17 feet in order to taper the air supplied. The diffusers are cylindrical tubes, 24 inches long and 4 inches in diameter, sealed at one end. Each is wrapped with Saran cord. The tightness of this wrapping directly effects the size of the bubbles emitted through the sewage. The average number of diffusers attached to each swinging tee is thirteen, however these can be varied to taper the air supply, also. They are positioned about 2 feet above the bottom of the tanks, giving an aeration depth of 13 feet.

The size of the newer tanks at Irwin is 242×28×15 feet. The aeration volume of all ten tanks is 623,984 cubic feet. It is essential that the bubbles be evenly, constantly distributed throughout. The Axi-compressors are especially well-suited to this service because they are not only pulsation-free, but they are positive-displacement units. Changes in liquid level in the aeration tanks would cause a change of the output volume if reciprocating machines were used; it does not with the Axi-compressors.

To keep the bubbles coming, the diffusers are cleaned every 6 months. Air must also be free from dirt and contaminants. It is drawn from atmosphere through American Air Filters to the compressors. Output is oil-free since no lubrication is required in the compression chambers of Axi-compressors.

Bubbles rise replenishing the supply of oxygen for the bacteria and constantly turn the sewage over. This action, together with the horizontal flow through the tank, imparts a circulating, helical movement to the sewage. Inflow contains 111 parts per million of solids in suspension, the BOD is 81 parts per million. At the end of the aeration cycle, there are 16 parts per million of solids in suspension, and the BOD is reduced to 7 parts per million.

From the aeration tanks, the effluent passes into flow-through clarification tanks. These are 100 feet in diameter and have a maximum depth of 9 feet. The liquor takes about 2 hours to pass through. About 25 percent of the activated sludge that settles here is pumped from the center of these settlers to the sewage as it enters the aeration tanks. The balance is sent to the digesters. This return of activated sludge constantly reseeds the inflow with a live mixture.

A portion of the return activated sludge (about 10 percent of the total) is pumped back to the incoming raw sewage.

Outflow from the clarification tanks is clear. Some 90–95 percent of the solids have been removed as well as 96 percent of the materials in solution. Following a 20-minute treatment in chlorine contact tanks, it is discharged into Irwin Creek.

Operation of the Sugar Creek and Irwin Creek domestic sewage and industrial waste treatment plants is a function of the Water Department, City of Charlotte. W. M. Franklin is the superintendent; R. S. Phillips, assistant superintendent; and L. S. Dukes, water & sewage plants supervisor. C. Murphy is the chief treatment plant operator at Irwin Creek; E. Blackwelder, at Sugar Creek.

This and That

Canada Looks For Oil

A $10,000,000 oil exploration program was carried out this winter in vast areas of the Yukon and Northwest Territories of Canada. Using both drilling and seismic operations, drillers concentrated on the Liard and Fort Good Hope plains. Some 30 or 40 oil companies took part and about 20 wells were put down in a continuing search for gas and oil in the country's north regions. Direct drilling expenses were in the order of $6,000,000, while about $1,000,000 was spent on roadbuilding, transportation and supplies. The number of wells drilled this year decreased somewhat from the activity of the 1959 winter when approximately 30 were bored. Wells were sunk this season in areas where preparatory seismic explorations had previously been done. Random drilling was thereby reduced.

★ ★ ★

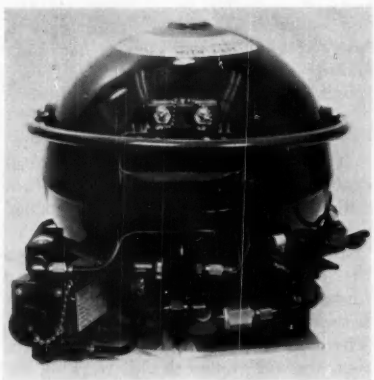
World's Smallest Packages

Normally things that are called world's largest and smallest turn out to be also ran's in the space of only a few months, especially nowadays. Scientists have come up with a tiny package, though, that might stand up as the smallest anywhere for at least several years. They are putting things into containers about the size of one of the smaller bacteria—0.00004 inch (one twenty-five-thousandth inch) in diameter. Indeed, the original research into the process was stimulated by studies of how living cells are formed. The technique is called microencapsulation and some of its industrial applications have already been patented by National Cash Register Company. The NCR process depends on deposition of a polymer film around a material to be encapsulated. The first use involved a colorless dye that, on contact with a reagent, gives color. A coating of the minute capsules is applied invisibly to a sheet of copy paper so that ordinary writing or typing pressure ruptures the capsules to release the dye. It is a replacement for carbon paper that already is in use. A wide variety of substances can be encapsulated, according to the Stanford Research Institute which is handling research into the program for NCR licensees. Solids, liquids and possibly even gases can be put into the tiny packages, to be released by such forces as grinding, pressure, heat, chemical dissolution or even enzyme action. Encapsulation can make soluble materials insoluble, or vice versa; it can make mutually reactive substances inactive, even though intimately mixed; it can make safer or more comfortable the handling of toxic or allergenic materials. The little capsules can be turned out as a dry, granular product, as aggregates in a plastic or self-sustaining mass, or may be incorporated in liquids or in solid or semisolid masses of other material. Applications are noted in such diverse areas as pharmaceuticals, foods, solid rocket fuels, fumigants and insecticides.

★ ★ ★

Compact Lox Converter

A liquid oxygen converter built by Linde Company, Division of Union Carbide Corporation, will supply breathing oxygen in aircraft of the U. S. Navy. Large savings in space and weight are possible with the unit. The 10 liters of liquid oxygen it carries aloft holds the equivalent of 8,610 liters or 304 cubic



feet of gaseous oxygen. Oxygen gas can be delivered at rates up to 150 liters per minute at an operating pressure of 70 psig. The converter, shown in the photograph here, supplies all the breathing oxygen needed in less than one seventh the space that would be required by a supply of gaseous oxygen. When full the unit weighs only about 44 pounds; an equivalent supply of oxygen in eleven high-pressure cylinders would weigh more than 225 pounds—or 181 pounds heavier. Of double wall construction, the converter has a stainless steel inner sphere and an aluminum outer shell. The space between the two contains insulation that reduces space and weight requirements and keeps oxygen evaporation loss to 2 pounds per day. Linde's converter will be used in the Navy's fighter and fighter-bomber aircraft. Similar converters will also be manufactured for Air Force planes, and larger capacity units will be built for use in long-range bombers and commercial aircraft.

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Hard Tack Never So Hard

A team of Swedish archaeologists came up with a piece of bread in old diggings in the central Swedish province of Uppland. Found within a circle of stones, the purpose of which is unknown, and surrounded by a charred layer that helped to preserve it, the bread is estimated to be 2500 years old. It is not the only archaeological find of its nature in the country, but it is one of the oldest. The recipe is not one that modern housewives would appreciate, however. According to researchers into ancient lore, and to scientists that have analyzed previous finds, the bread contains not only grains, but weeds and traces of nitrogenous matter that is thought to be decomposed blood.

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Magnetic Shoes For Space

According to a report, *Walking Under Zero-Gravity Conditions*, prepared at the Aerospace Medical Laboratory, an old Buck Rogers idea does work. In the weightless free-fall of outer space, magnetic shoes should enable a spaceman to walk on a ferrous metal deck, wall or roof with equal ease and be spatially oriented with regards to the location of his feet. In other words, *down* is where the feet are. Experiments described in the bulletin include ones conducted aboard a C-131b aircraft in which each of four airmen were equipped with sandals made by bolting permanent magnets through rubber shims to aluminum soles. In the weightless parabolic path familiar as our only current means of producing weightlessness, the four men could walk in "an almost normal manner" either rightside up on the floor of the plant, or upside down on the ceiling. All reported "foot down" orientation.

Compressed Air Oddities

Less Dust Above Notre Dame?

Two groups of sacks filled with coal were shaken out on the ground. From one puffed a thick cloud of black dust. From the other, nothing. This recent demonstration on the outskirts of Paris showed the effectiveness of a new antidust agent called Coal-Caso. The liquid was developed by France's Solvay Company and when sprayed on coal under some 22-psig pressure, seals in all dust. From 4 to 6 quarts takes care of a ton of the fuel. Coal dust contributes heavily to air pollution in all of the larger French cities. According to the fortnightly *France Actuelle*, public health authorities in France are interested in the liquid as a possible means to combat the contamination.

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Jasperized Wood And Tigereye

Jasperized Arizona wood, tigereye, lapis lazuli and idocrase are a few of the many semiprecious stones that can be found in virtually every part of the U. S. The stones can be obtained for only the time it takes to seek them out in glacial drifts, quarries or along beaches. Amateur lapidarists grind and polish the stones into beautiful pieces of handiwork and jewelry. A free booklet just published by The Carborundum Company, entitled "An Introduction to the Art of Lapidary," tells something about these stones and how to work them (available from Advertising Branch, The Carborundum Company, P.O. Box 337, Niagara Falls, N. Y.). Designed to serve as an introduction to the most popular phrases of lapidary, the 14-page digest-size booklet explains the preparation of carbochons (curved or flat-surfaced stones), and of baroque stones through tumbling. Both of these operations are used in fashioning many kinds of stone jewelry and are skills that the amateur can readily acquire.

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Tests For Grain Storage

A sausage-shaped plastic bag and 25,000 bushels of grain are the protagonists in a dramatic test that began late last year. The question to be answered is whether or not the plastic bag can replace the grain elevator. The container is 100 feet long and about 30 feet in diameter. Grain was blown into the bag, then the air withdrawn, creating a semivacuum. The crumpled container will stand about a year in the weather, after which time it will be opened and the grain tested. If the idea works, farmers may be able to store their own crops for about 5 cents a bushel, rather than at the current 30-cent cost.

In semidesert areas of the Southwest, range cattle are faced with possible starvation during protracted periods of drought. One of the few things that grow under such severe conditions is the cholla, which includes any of the tree-like, very spiny cacti. More common names are prickly pear or Indian fig, which refer to the sweet-tasting fruit of the plants. Driven by hunger, cattle sometimes eat the pears and suffer sickness or even death from the needle-like spines.

Having observed that the spines are dry and the pears are not, the United States Forest Service found by experimenting in 1921 that the needles could be burned off without damaging the fruit, which the cattle could then safely eat.

A burner, to be carried on the back like a knapsack, was then devised, using kerosene for fuel and compressed air to burn it and spray the flame through a nozzle. The first burner, with fuel and air tanks, hose and nozzle, weighed 12 pounds and the air was replenished as needed with a hand pump. Refinements have been made and a small gasoline-engine-driven, air-cooled compressor mounted in a pickup truck now goes along to supply the air. On cattle ranges in Arizona and Texas, "burning pear" is now a regular part of the cowboy's life. A gang of burners can despine enough pears in a day to feed 100 to 150 cattle.

In 1899, Air Pillow & Cushion Company, of Moberly, Mo., began turning out pneumatic beds, pillows and cushions for domestic use. It had been making them for hospitals and sick rooms for several years.

It was discovered in 1890 that horses can't live under high air pressure but mules can. These facts were learned during the driving of the St. Clair (Sarnia) tunnel under the St. Clair River that connects lakes Huron and Erie and forms part of the international boundary between the United States and Canada. The underwater portion was excavated with the aid of two shields working under air pressure and advancing toward each other from Port Huron, Mich., and Sarnia, Ont.

The clay making up the riverbed was cut down in slabs by men working in front of the shields and loaded into small cars for hauling back through the completed section to the outside. An attempt to use horses to draw them showed that the animals could not withstand the effects of the abnormal pressure, which reached a maximum of approximately 25 psig. Mules were then successfully tried. Thereafter, they worked in pressurized sections. After cars were locked out into normal atmospheric air pressure, horses hauled them to the disposal areas.

Nowadays, of course, mechanical haulage is used in such tunnels; in fact the Sarnia was probably one of few in which draft animals were employed.

Why is a blimp a blimp? Because during World War I the British used a small nonrigid type airship which they called the "limp" type to distinguish it from rigid Zeppelins. The word "blimp" came into the language, according to Goodyear Aircraft Corporation (the nation's only blimp maker), from a "Type B" limp airship which was widely used as a submarine spotter.

Before the widespread popularity of air conditioning, inventor Dr. F. K. Kirsten came up with an air conditioned bed that cooled the sleeper in summer and, by means of electric coils, warmed him in winter. According to the September 1940 issue of this magazine, the bed consisted of a metal box frame over which was stretched a material sufficiently porous to allow air to flow through slowly. Air, under a pressure of 150 psig, was stored in cylinders in the basement of the house and was piped to the bed where it was introduced into the frame through a reducing valve at a pressure of $^1/_4$ psig. A single special covering was provided—a double blanket, connected at the foot of the bed with small tubes that led air into the intervening space. This air, reduced in pressure, passed out through the opposite end and around the sleeper's shoulders. Two decades ago, aeronautical engineer Kirsten said that insomnia would become an obsolete word!

In 1912 fire caused by a short circuit broke out in a telephone switchboard at the Baldwin Locomotive Works in Philadelphia, Pa. There being no water handy, a resourceful employee seized an air hose and blew out the flame.

EDITORIALS

Water Pollution Control

ELSEWHERE in this issue we describe the compressed air plant used in connection with sewage treatment facilities. The specific installations referred to are in Charlotte, N. C., and according to a letter received from the North Carolina Department of Water Resources, "The city is to be highly commended for the steps taken to meet its responsibilities. . . ."

The word *responsibilities* is an apt one because the cure and prevention of pollution problems is, in fact, a responsibility for all. Cities, municipalities, industries, must all accept the fact that the preservation of vital water supplies must be accomplished, and quickly, if we are to maintain the growth of our cities and towns and the expansion of our industry and material well-being.

The use of large quantities of compressed air in the plant described, which is typical of many throughout the country, is just one more instance of its use to make more efficient, less expensive, better, even practical, the things that are basic to our existence.

That we have a tiger by the tail is obvious from a report recently issued by Dr. Luther L. Terry, Surgeon General of the United States Public Health Service. The survey included the 48 conterminous states, the District of Columbia, Puerto Rico and the Virgin Islands. It revealed that we need approximately 5200 new sewage treatment plants, plant enlargements and replacements. These carry a hefty price tag estimated at $2 billion. They are needed to treat municipal wastes now being discharged into the nation's water resources from a population of about 42 million. The Public Health Service estimates that these needs, together with new ones resulting from plant obsolescence and population increases can be met with an annual expenditure of $600 million. This is a 40 percent increase in the rate of present construction.

We have been making some strides to solution of the water pollution problem. Since the passage in 1956 of the Federal Water Pollution Act, a total of 2632 projects have been approved for grants of $216 million. The Act allows grants of 30 percent of the total cost, or $250,000, whichever is less. Each dollar of Federal funds has been matched by $4.80 in local monies and the total costs of the projects so far approved thus adds to $1.3 billion. These projects will serve areas having a population of 24 million and will abate waste pollution of some 31,000 miles of streams.

Imaginary Savings

A CONTRACTOR recently purchased a track assembly for his crawler tractor. The original equipment had worn out after 3305 hours of operation. The contractor was cost conscious as are all businessmen today, so he did some shopping. The original equipment manufacturer's price for the replacement was $795. The unit ultimately purchased was obtained for a price of $395, a figure slightly less than half the price of original equipment. The savings were obvious—at first. But because the businessman was wise, he did some further checking.

His bargain, it turns out, was an expensive one. After 700 hours the replacement wore out. The figures show that the original equipment worked at a cost of $0.24 per hour. The replacement worked at a cost of $0.56 an hour, more than twice as much. Furthermore, over a span of 3300 hours of operation, by using the cheaper replacement, the contractor's piece of equipment would have been out of service at least 4 times, and these down time charges would have to be charged to the repair assembly. What's more, the cost of putting the spare track assembly on the tractor is an expensive item in itself due to high labor costs and these charges, of course, would be at least 4 times as high.

There are many reasons why substitute "just-as-good-as-original" parts fail. Most of it has to do with experience. That ubiquitous quality dictates materials and tolerances, surface finishes and balance—all the things that the original equipment manufacturer has learned the hard way through research, testing and field service. Original equipment manufacturers have been most successful in their campaign to sell equipment on the basis of the work that it can do—the cost per yard of earth moved, per foot of hole drilled, per piece of metal turned.

The next step then is to sell parts for repairs on the same basis. This is urged simply as wise management of operating costs. The original equipment manufacturer, to be sure, has a vested interest in seeing his repair parts used on the equipment he made. His reputation for the entire machine eventually rests on its over-all service life, thus is at stake with each parts sale. We think that the proper attitude in purchasing spare parts is that one should buy just a little more than a part that will work or that will fit. The idea should be to buy parts that result in the lowest operating cost and this aim is almost exclusively attained by buying "original equipment" or factory-authorized spares.

Peter Sleight

MONOFORM

FORWARD-THINKING builders speak about Monoform. They are referring to a system being marketed by The Flintkote Company whereby better roofs can be laid in a relatively short time. The ingredients are glass fibers, an asphaltic compound and compressed air. Equipment includes simply a portable rotary compressor and a special long-nose "gun"—known as the Sealzit Big R.

A year ago the system was demonstrated at The Flintkote Company's research laboratory in Whippany, N. J. Since then, use of the Sealzit guns has spread throughout the United States and Canada. Even with this acceptance, company spokesmen feel that the method is still in its infancy, that its highly successful applications are just an entry into many fields. Other uses slice through the broad construction, industrial and agricultural markets. The Monoform System can be applied in laying sidewalls and insulation; in maintenance and repair jobs, sound deadening and pipe coating; in forming corrosive protection on tanks and waterproofing for animal shelters and irrigation ditches. One of the most unique jobs to date was the lining of Atlas missile firing silos near Plattsburg, N. Y.

The Monoform System was developed to replace the conventional method of laying up a roof—putting down successive layers of felt and hot-mopping asphalt between each. This is long, involved and tedious. It is further complicated by today's architectural configurations and the necessity of laying roofs around air conditioning vents, exhaust fans and similar protrusions. Toroid, thin-shell, paraboloid, curved—now the architect can reasonably specify any of these roofs knowing that the Monoform System will make them practical to install. The reinforced asphalt emulsion covers evenly, conforming to all shapes and covering small gaps. There is no flow, even on vertical surfaces. The finished membrane is without seams.

Depending on the human speed factor, application rates can reach 18,000 square feet per day with a 3-man crew, according to the skill of each workman. With conventional methods only 8000 square feet a day can be put down, and five men are needed. The finished Monoform membrane provides inherent structural strength, adding only 1.5 pounds per square foot. Conventionally laid roofs weigh about 5 pounds per square foot.

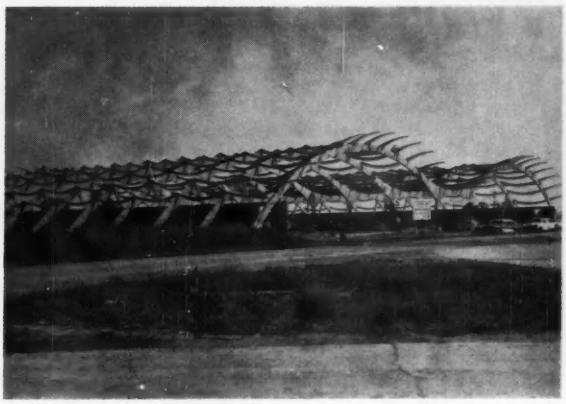
The Monoform System was born with the development of the Sealzit gun and asphaltic compounds that have proper wetting characteristics for incorporating chopped glass fibers into the finished film. Its name comes from the application technique itself—putting down a 1-phase, monolithic membrane of asphaltic emulsion compounds simultaneously with glass fiber reinforcement. The contractor first clears the area to be covered of rubbish and debris. When the surface is cleaned and sufficiently dry to assure proper bonding, and the temperature is above 40° F, laying can begin.

Three men do the job: one handles the gun, another takes care of hose, and the third works with the compressor and pumping equipment on the ground. Required air at the positive-displacement pumps and gun (that is, the cutter and atomizer) is 28 cfm. It is delivered from a portable compressor through $^3/_4$-inch hose, $^1/_2$-hose and finally $^3/_8$-inch line at the equipment. The cutter uses 17–20 cfm at 70–100 psig pressure; the atomizer, 15.5–25 cfm at the same pressure. Pressure drop through $^1/_2$-inch hose is 5 psig every 100 feet. Pressure drop through the pump is 20–25 psig to the atomizer hose and another 25–35 psig through cutter hose.

Considering these data, Ingersoll-Rand 125-cfm portable Gyro-Flo compressors are recommended. They are easy to move to the worksite, are compact when congested areas are encountered, are economical, and supply enough air at 110-psig pressure to assure efficient gun and pump operation.

The 3-barrel Big R gun is simple to operate. Two nozzles spray the asphalt compounds, special formulas developed by Flintkote's Product Development Group and its Research Department. From a third opening between them comes chopped glass fibers. These fan out to become a random, interlocking pattern in the finished film.

Either Owens-Corning or Pittsburgh glass fiber roving is fed through a Teflon guide and picked up by the cutter mech-

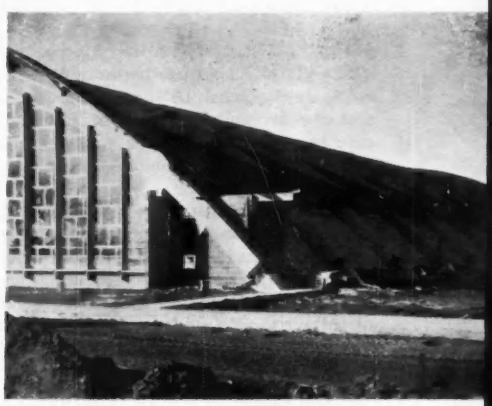


anism. This device and the gun itself follow the basic operating techniques of one developed by Rand Development Corporation. They are the result of continuing programs of research previously reported in this magazine (See "The Realm of Research," October 1959).

The cutter consists of two tangential cylinders. One is metal in which single-edge Schick injector razor blades are clamped. The other is covered with silicone rubber. These rotate in opposite directions pulling fiber glass roving between them. The thin blade edges press the fibers into the soft rubber, causing them to bend at a sharp angle and break. Since the snapping is not dependent on blade sharpness, a single set of blades lasts for hundreds of pounds of roving. When they must be replaced, the job is simple and inexpensive.

The Sealzit guns are leased for 3 years to franchised roofers by The Flintkote Company. Before each gun is supplied to a contractor, he must attend a training school. It lasts 2 days, during which time the operation of the gun is thoroughly explained. An expert always accompanies the contractor on his first job. There are more than 180 franchised roofing contractors at present.

In November 1960, Flintkote acquired licenses under Rand Development Corporation and Canadian Ingersoll-Rand Company Ltd.'s spray-up process patents. Flintkote received the benefit of Rand's pioneer work in reinforced plastics. The agreement between the two companies permits Flintkote to combine its Sealzit gun with the Rand developments. It puts Flintkote in a position to expand the markets and to contribute to all phases of the reinforced plastics industry.



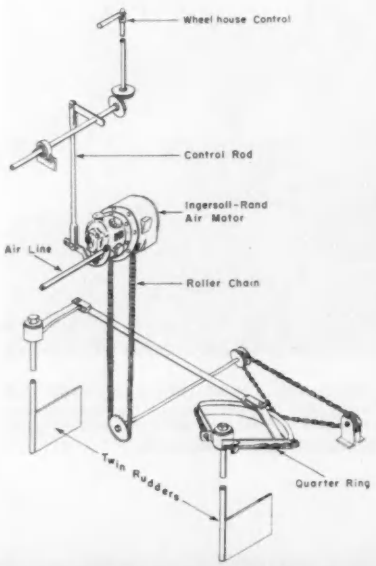
CONTEMPORARY SHAPED No matter what type of roof an architect specifies, it can be covered quickly and conveniently with a Sealzit Big R gun. Two bowling centers are shown here before, during and after coating.

PREPARATION AND COVERING A portion of a 270,000-square-foot roof in Massachusetts. Some 1000 tons of old roof built over insulation board and gravel surfacing had to be removed (left). A bucket loader did the job. In the background can be seen some of the Monoform System roof. The new roof was laid fast and in a continuous application with the Sealzit gun. Note how easily it gets around ventilators and bases, which are also sprayed with the asphalt-fiber glass compound.

TRUE-TURNING TOWBOATS

STEERING is a touchy problem for boats that work in close waters. To give the skipper peace of mind, fast and sure handling are essential. If a craft doesn't have these, maneuverability and speed suffer.

An example of the need for precise control is obvious if one watches the towboats working the Intracoastal Waterway and the narrow, winding Louisiana rivers that feed into the Gulf of Mexico. Boats that have manual steering tend to weave from side to side in the narrow channels. They seldom can proceed in a direct line but often take a less efficient wavering course. The resulting loss of time wastes not only minutes but money as well. This is true because the measure of a towboat's value comes from the speed with which it nudges cargo from loading to off-loading point. (*Tow*boats rarely pull their barges, normally they push them.) The more cargo it can move in a given period, the more income.



The LeBoeuf Bros. Towing Company, Montegut, La., has proved the value of sure steering by installing an air-powered system on two of its towboats. The first was rigged on the *Samson* in March 1960. The new apparatus allowed the boat to move more nimbly, and hence, more swiftly. In 2 months *Samson* increased its earnings by $1200, the cost of the equipment and its installation. The boat increased its annual earning ability by $7000.

The newest towboat of the shipping concern is *Enterprise*. She too has been given an air-steering system. *Enterprise* was built by Universal Iron Works at Houma, La., in the summer of 1960. An all-welded vessel, she is 57 feet long, has an 18-foot beam and draws 5½ feet of water. She has twin screws powered by a pair of General Motors diesels, each of which produces 355 hp at 1800 rpm. The diesels drive 50-inch-diameter stainless steel propellers through 4.15:1 reduction gears. Besides the two vessels mentioned here, LeBoeuf Bros., operates ten other towboats and 24 barges. The company, organized in 1943, transports petroleum products in the Gulf region.

Basically *Enterprise*'s air-steering gear is the same as the one on *Samson*. A pilot house lever turns a 1-inch control rod supported in roller bearings. The rod regulates the air admission valve of an Ingersoll-Rand Size AC air motor hoist in which a roller chain sprocket has been substituted for the usual link chain sprocket. The roller chain, powered by the motor, rotates a transmission rod which turns a quarter ring by means of a second chain. The ring is fixed to one rudder stem and linked to the other. Compressed air is supplied at 80-psig pressure by the boat's general service unit.

The air motor chosen for the installation is a heavy-duty, 4-cylinder piston type with cylinders arranged radially. It is reversible with graduated speed and automatic brake in either direction. Thus, the rudder is held firmly in any position without need for any other brake.

Experience with the *Samson* convinced LeBouef Bros., of the performance and economy of the air set up. With it the boat and its tow can steer a straight course and maneuver with sureness. It is estimated that a hydraulic system with its hydraulic ram, pump, and electric motor would cost two or three times as much as the simplified air system.

On *Enterprise* air steering was used not only for the two main steering rudders but also to operate two flanking rudders that control lateral movement. To accomplish this, duplicate systems were installed, each with its own Ingersoll-Rand air motor. With all rudders air-controlled, the *Enterprise* is a steady, responsive, maneuverable craft. She operates on the winding Ouachita River in northern Louisiana and makes 10 knots running free and about 5 with a 50,000 barrel tow.

AIR MOTORS The picture at right was taken as the air motors were being installed aboard "Enterprise." Closer unit controls the main steering gear and is completely hooked up. Other unit, which handles flanking rudders, still needs its control rod.

On His Birthday, The Fahrenheit Scale

GABRIEL DANIEL FAHRENHEIT was born in Danzig 275 years ago this month, on May 14, 1686. Although he lived most of his life in England and Holland, biographers refer to him as a German physicist. At 15, when both his parents died, he was taken from his studies at the gymnasium to serve an apprenticeship in a Dutch business firm. After 4 years, he began studying physical science and meteorology. Fahrenheit's income was undoubtedly derived from making meteorological instruments.

He became a member of the Royal Society in 1724, an indication of the esteem with which he was regarded. Besides the scale that bears his name, Fahrenheit is noted for his improved hygrometer. He died a 50-year-old bachelor in Amsterdam on September 16, 1736.

To those who work with the Celsius (Centrigrade) scale, the figures 32 and 212 seem clumsy. For the layman who wants to know "what the temperature is," the scale is most convenient. Why Fahrenheit chose 32 and 212 is a mystery, and the facts leading to the scale allow wild speculation. To arrive at what may be an accurate answer, the clock must be turned back even further than 275 years—to the 1590's.

Galileo invented the air-thermoscope sometime between 1592 and 1597. It consisted of an open-end tube, probably glass, with an air-filled bulb blown at the top. This bulb was warmed and the open end of tube inserted into a container of colored wine. As the top bulb cooled, the air in it contracted and the wine rose in the tube. The higher the spirits, the lower the temperature. Although the air-thermoscope crudely indicated differences in temperature, it was considerably affected by atmospheric pressure and was actually more barometer than thermometer.

Improvements were made in every scientific quarter. A scale was probably added by 1613, for a letter written that year from Francesco Sagredo to Galileo refers to "100 degrees." There is no question that degrees, or divisions, were known in 1624, for *La Recreation Mathematique*, written by F. Jean Leurechon and printed at Pont-a-Mousson that year, described the thermometer as "an instrument for figuring degrees of heat and cold that are in the air."

The first hermetically sealed thermometer generally used was that favored by Grand Duke Ferdinand II of Tuscany in the 1650's. These instruments were popular in the Accademia del Cimento, Florence, and became known as Florentine thermometers. Some were very elaborate works of glass, but the readings were unreliable and the designs varied considerably. The *Saggi di Naturali Experienze* (published by the Accademia del Cimento in 1666) shows them with degrees indicated by enamel beads fused on the tube running between the upper air-filled and the lower alcohol-filled bulbs. Each degree represented a thousandth of the volume of alcohol in the bulb. It is easy to see how these instruments could vary, for manufacturing techniques were crude and the products were not standard.

In an effort to improve accuracy and make all Florentine thermometers alike, a fixed point had to be established. This was generally determined by the freezing point of water. A second constant point was needed to make the scheme practical, for only then could the tube be subdivided. With such a double constant-point system, the size of the bulb would be of no concern. In 1701, Sir Isaac Newton proposed that the scale should go from the melting point of snow to the temperature of the human body, designated in his *Scala Graduum Caloris* as 0 and 12 degrees. He used alcohol, mercury having too small a coefficient of expansion.

In 1714, Fahrenheit also chose two natural starting points. Like Sir Isaac, he picked the temperature of the human body for one. This he said was 90 degrees. The freezing point of water was used for the second mark—30 degrees—rather than the temperature of melting snow. Fahrenheit must have been influenced by Ole Roemer, the astronomer of Copenhagen who determined the speed of light, when he established his zero.

Roemer made a thermometer with the lower point determined by the temperature of snow and ice, and the upper by the boiling point of water. The space between was divided into 15 degrees. Because he was using his thermometers for meteorology, the higher temperatures were unnecessary. Therefore Roemer divided the scale in half and located a third point this same half-distance (7.5 degrees) below the first low-point calibration. This third point he called zero.

Fahrenheit, who had visited Roemer in 1708, also divided his scale between the freezing point of water (30 degrees) and the temperature of the body (90 degrees) in two equal parts, and extended his scale beyond 30 to 0 degrees. Thus it can be said that the first Fahrenheit scale ranged from 0 to 90. Some researchers have suggested that zero for Fahrenheit was the coldest day he knew in Danzig. Others say it was the lowest temperature recorded by him in Iceland, where he is known to have checked his thermometer. The exact reasons for his picking 30 and 90 are really unknown.

A short time later Fahrenheit refined his scale by making the upper mark 96 rather than 90. Perhaps this was because the former has more integer factors than the latter, eliminating confusing fractions in the scale. Perhaps it was a refinement of the 0–12 degree scale of Newton. Nevertheless, the Fahrenheit scale was settled.

After Fahrenheit proved that when ice began to form, temperature always rose to the same point, freezing became 32 degrees. Thus the scale as we know it today was established with the freezing of water at 32 degrees, the body temperature at 96 degrees (later set at 98.6), and the boiling point of water at standard conditions (960 mm Hg barometric pressure) at the previously measured 212 degrees. The interval between 32 and 212 was divided into 180 equal parts. Some zealous, though inaccurate researchers, thought that 212 was selected because it was 180 degrees from 32, the same number of degrees in a half circle and a figure that would be appealing to an astronomer like Fahrenheit. The same researchers do not say why the figure 32 was picked. Their work seems to be without foundation.

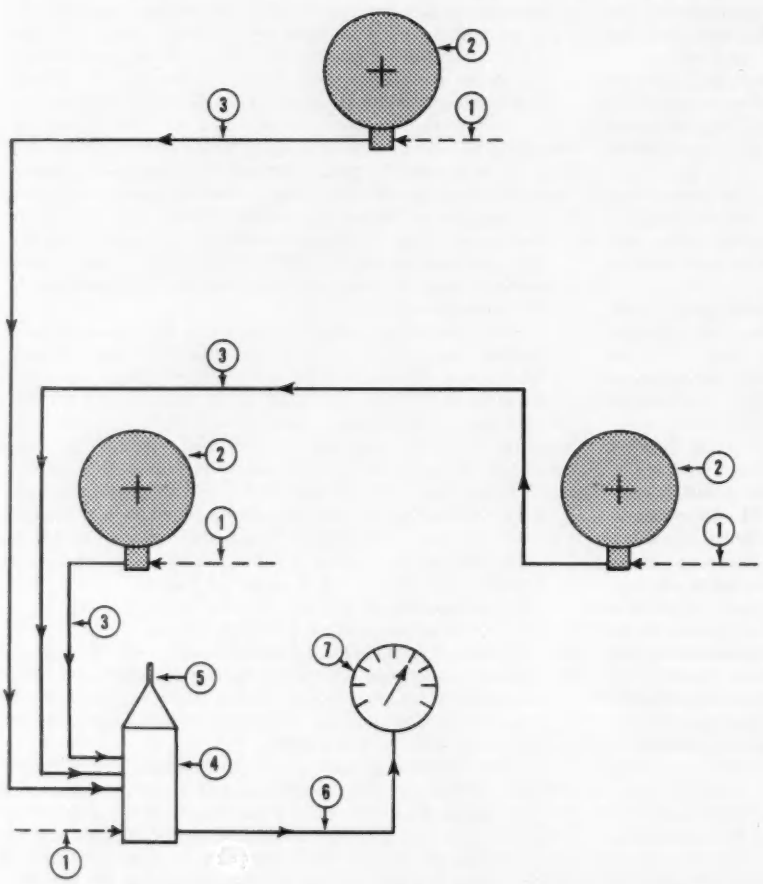
Gabriel Fahrenheit was successful with both alcohol and mercury, and it was he who was the first to construct mercury thermometers having reliable scales, according to Henry C. Boldon's *Evolution of the Thermometer 1592–1743* (Chemical Publishing Company, 1900).

What are the advantages of Fahrenheit's thermometer? For one, mercury expands almost exactly one ten-thousandth of its volume at 142° F for every degree in the Fahrenheit scale. For another, the coldest temperature that can be obtained by mixing snow and salt is near the zero of Fahrenheit's scale. To be mentioned as well are the thermometer's early introduction and quick acceptance. The small space between each degree in the scale and the freezing point being above zero made the thermometer ideal for meteorological work and for telling air temperature in moderate climates where minus figures are cumbersome. It is to Gabriel Daniel Fahrenheit that we owe thanks for one of the early standards still in use today.

Weber Air-Weigh Systems

AIR CELLS can accurately determine the amount of liquids or solids in bins, tanks, silos and truck tanks, on conveyors or truck beds, and in many other containers, as well as the quantity of material passing through continuous-flow processing equipment. The cells may be coupled with low- or high-limit relays, to enable the net load signal obtained in weighing to do useful work. Thus containers can be filled or emptied automatically. These air cell-relay signals can also operate, either continuously or at preset limits and times, remote printers, card punching equipment and similar devices used for inventory control.

Extending this cell-relay setup, it is easy to see how load cells can control mixing and batching. In addition to preset high- and/or low-limit relays, the pneumatic circuitry might include automatic resets, batch counters, time delay relays, pneumatically operated electrical switches and the like. A typical system might continuously weigh the net contents of a mixing tank or hopper. Here's how. The first ingredient is added until a preset weight is achieved. The weighing cell would then transmit a pneumatic signal to a limit relay. When the relay is activated, it in turn would close one valve or gate feeding into the mixing tank and open another. The cycle could be repeated with each ingredient until all are properly proportioned. Then the system would automatically dump and reset. Variations may also be worked out.



SCHEMATIC FOR 3-LEG TANK Clean, dry air (1) at 100-psig pressure is fed to the three Weber Air-Weigh cells (2) and the averaging relay (4). Each load cell supports one leg of the tank. Air signals (3) from cells are linearly proportional to the imposed load supported by each cell. The averaging relay has a tare-out settling device (5) that pneumatically eliminates the portion of output signal due to tare weight of the supported container. Air signal (6) is also linearly proportional to net contents of the container. The read-out dial (7) may be calibrated in pounds, gallons, barrels, etc., and is accurate to within 0.25 percent of the net contents.

Air cells are equally as effective with solids. For example, they are adaptable to continuous-flow situations with conveyors. Through the load cell, a signal is produced that is always proportional to material on the belt. This can be fed to a totalizer for recording total material moved or to a controlling device to correctly proportion another component of the process, say a piece of processing equipment or a simple proportioning feed system.

Typical air cells for these inplant process and inventory control applications are manufactured by Link Engineering Company, Detroit, Mich., under license from Weber Air-Weigh Company. Harrob Industries is the exclusive national sales agent. Units currently available can accurately weigh in the range of 200 to 240,000 pounds. Combinations can be made for higher capacities. The Weber Air-Weigh System, as it is called, is quick and easy to install. A 4-leg installation for a 30,000-pound tank or storage bin, for example, can be completed in less than 60 minutes. No expensive or time-consuming changes are required in floors or foundations because the air cells sit right on the floor.

A small load cell is placed under each leg of a tank, bin, conveyor or other structure. The height adjusting screw (*see schematic*) of each cell is turned, raising the unit to be weighed so the container is floating on a column of air in the load cell. This adjustment compensates for variations in floor level. A differential of as much as $^1/_4$ inch can be corrected so that each leg will support an equal share of the container load.

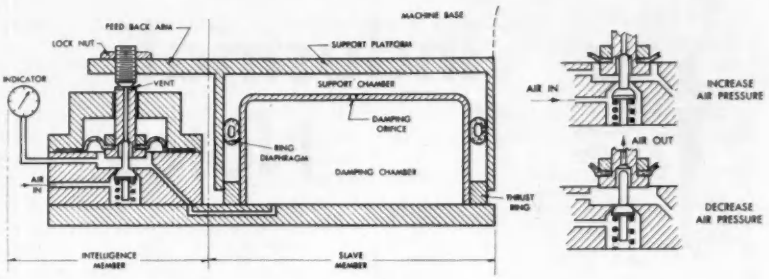
Weber air cells are constant-height devices, regardless of increasing or decreasing loads in the tank, container, conveyor or machine. For a given increase in load there is a corresponding and automatic increase in air pressure to balance the load. According to the com-

pany, the units are accurate to within 0.1 percent.

With a natural frequency of less than five cycles per second, the Weber Air-Weigh load cells will absorb vertical vibration developed in some types of mixing tanks and prevent its transfer to floors. Tank level is maintained at the same time.

Normal factory air supply is sufficient for the cells. However, air must be filtered to assure that it is clean and dry. A filter is recommended directly ahead of the system. Air consumption is minimal, since the cells are essentially closed-end types. There is no appreciable drain on the shop air. Pressure requirement is 100 psig for maximum capacity per cell.

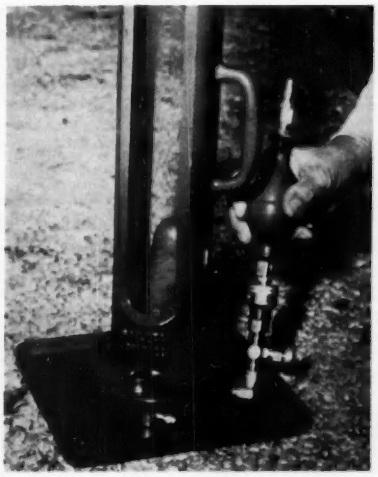
Linear pneumatic pressure is automatically controlled in each load cell so that resulting signals are directly proportional to the load. Any changes in load are then read on a remote indicating meter, controller, printer or other device. Tare weight is pneumatically compensated for, leaving net weight.



SCHEMATIC CUTAWAY OF LOAD CELL **Over-all length varies from 9.5 to about 23 inches, depending on the capacity of the cell. Diameter of the slave member also ranges from less than 7 to 20.5 inches. Height is $3^{1}/_{8}$ inches for all models.**

For civil engineers,

Soil Density Checks Made Easy



ONE of the most widely applied tests in civil engineering construction is that to check soil density. It is used to determine the degree or amount of compaction of bases of roads or airfields; fills for dams, embankments, and levees; and similar structures. Proper compaction will usually assure a stable and trouble-free road or construction base.

Soiltest's Volumeasure is a unit designed to determine the in-place density of soils by a rubber balloon method. It consists of a calibrated glass cylinder, guard, actuator bulb, rubber balloon and base plate. Basically, liquid contained in the glass cylinder is pumped into the balloon which expands to fill the hole from which a test sample has been removed.

In detail, here is how the operation goes. Before digging the density hole, the Volumeasure is placed on the density plate (*left*). The liquid-filled balloon is forced against the leveled ground surface to obtain the initial reading. Then the test hole is dug, using the field density plate as template. The complete soil sample removed from the hole is retained in a sealed container for later use in checking moisture content and weight.

The actuator bulb (*center*) is of the 2-position type. One side allows the operator to develop a pressure in the calibrated cylinder, forcing the liquid into the balloon which fills the density hole. The bulb's vacuum side assists in removing the liquid from the balloon and density hole. A quick coupler assembly is included for easy reversal of the actuator bulb.

The Volumeasure actuator bulb is pumped, forcing the pressure fluid into the balloon to fill the density hole (*right*). A reading is taken when the liquid level in the calibrated glass cylinder reaches equilibrium. The initial reading is subtracted from the final reading. The difference is the volume of the density hole. The soil sample obtained from the hole is then weighed before and after drying to obtain the moisture content and the dry weight of the material so that the soil density can be computed.

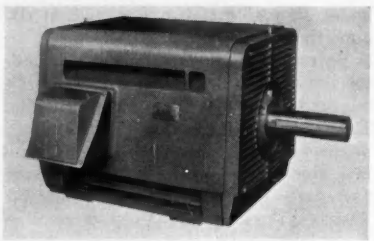
Apparatus of this type is restricted to tests of relatively firm, bonded soil masses. The rubber balloon method for determining the density of soil in place is a proposed ASTM tentative specification.

Industrial Notes

THIS feeder-hopper for moving bulk materials or small parts uses air-powered vibration. Designed for accurate, close control of material flow, Model 24S4 125 is 2 feet long with a $1^1/_2$-cubic-foot

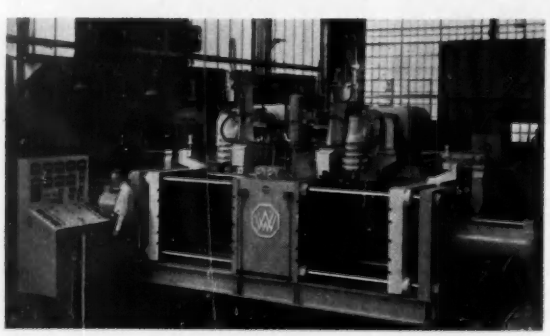
hopper. Flow is accurately regulated by adjusting the air supply pressure and can be instantly started and stopped by a quick-acting manual or solenoid valve. It can move 6000 pounds of dry granulars per hour. The manufacturer states that its completely enclosed tubular steel feeder is ideal for handling cement, fly ash and other dusty powders. Aluminum and stainless steel models are available for food products, chemicals or any material that must be kept free from contamination. The smooth conveying surface resists abrasion and can be cleaned with common cleaning agents. There are no moving parts to come in contact with the material being handled. The metal hopper located above the feeder can be attached with a dust-tight flexible boot. Compact supporting structure saves space and eliminates additional mounting when the feeder-hopper is installed. An air-powered vibratory drive unit mounted under the feeder supplies the force to move the material. Automatic lubrication of its one moving part reduces maintenance. Completely enclosed, the feeder will operate while submerged in a liquid. *The Cleveland Vibrator Company*, 2828 Clinton Avenue, Cleveland 13, Ohio.

RELIANCE Electric & Engineering Company has put a round peg in a square hole to reduce the over-all size of large a-c motors. Its new motor, called Duty Master D-5000, has a round stator inside its nearly square frame. This unusual arrangement provides better cooling, permitting the use of a smaller over-all dimension for any given horsepower. The D-5000, which is currently available from 125 to 300 hp and will be designed for 2000 hp early next



year, has large air intakes that cover each end of the motor. Air is drawn in these louvered openings, ducted through the rotor and stator, and exhausted at the sides. The result is more efficient cooling, thus more horsepower. The motor is being offered with either sleeve or ball bearings. Drip-proof enclosure is standard, but splash-proof enclosures can be specified. In addition, encapsulated stators are available for severe conditions. *Reliance Electric & Engineering Company*, 24701 Euclid Avenue, Cleveland 17, Ohio.

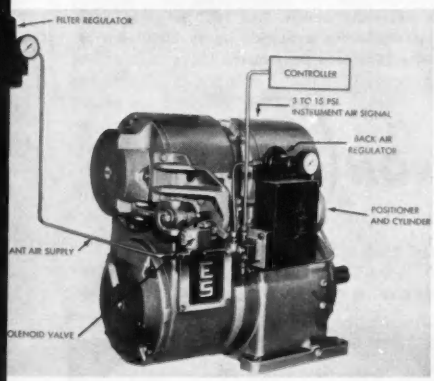
ABSOLUTE, a filter vacuum cleaner designed to handle radioactive and toxic dusts, is described in a 4-page illustrated bulletin. Included are detailed descriptions of filter design, maintenance procedure, tested efficiencies, and the accessories and special modifications that are available. *Cambridge Filter Corporation*, 738 Erie Boulevard, Syracuse 1, N. Y.



PLASTIC containers with capacities as large as 80 gallons can be blow-molded in a machine designed and built by Williams-White & Company, Moline, Ill. The unit shown in the accompanying photograph was installed at a plant in Rock Island, Ill., for Plasticon Corporation, Minneapolis, Minn. The blow-molding unit is hydraulically operated and works in tandem, two units being produced simultaneously. A plastic tube is extruded vertically downward between the mold halves. The shells close against the tube, sealing it, except where a blow-pipe is inserted. Compressed air at about 40-psig pressure is then "blown" in forcing the plastic against the mold. Copper pipes encircle the mold for cooling. Once removed from the machine, the molded component is trimmed of excess plastic.

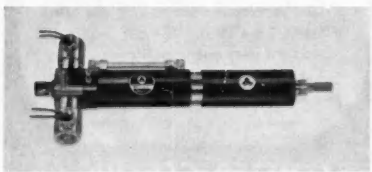
The parts illustrated here were formed by air from a 10-hp Ingersoll-Rand Type 30 compressor with a capacity of 53 cfm. Plasticon Corporation plans to connect a 105-cfm capacity unit. The plastic used is a granulated, linear, high-density polyethylene that is normally translucent but which can be colored by addition of pigment. Before the molding operations, the granules are poured into a heater to create a viscous material. The plastic is fed into the molds through an $8^1/_2$-inch diameter extruder built by John Royle & Sons, which is located in Paterson, N. J.

AIRtrol is a low-cost method of supplying automation to plants and processes and is described in Bulletin G-2500. The unit is an automatic variable speed device, air powered, that is attached to a Reeves Motodrive. AIRtrol actuates the speed changing mechanism in a standard a-c motor, shifting to speeds throughout the Motodrive operating range, and the Motodrive changes the output speed of the motor. Regulated and filtered factory air at a pressure of 40 or 60 psig operates the AIRtrol shifting piston which opens and closes the driving pulley. This high pressure operating air is put in or exhausted from the piston by a pilot valve, which responds to the low pressure air signal generated by sensing instruments. An important feature of the unit is that it offers a unique solution to problems of controlling solids when coupled to conveyors and other material



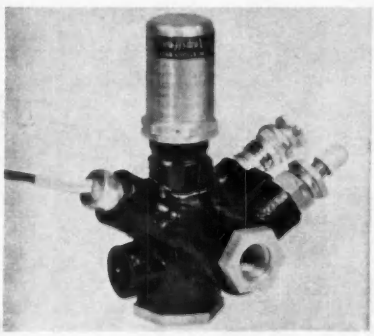
handling machinery. It can be applied to open and closed loop control of both liquids or solids. It may be coupled to a pump, conveyor or blower to form a final control element. A typical drive operates from a pneumatic signal of 3 to 15 psig, and produces an output speed directly proportional to input signal. Drive is limited to applications requiring less than 60 hp, and less than a 10:1 speed range. *Reliance Electric & Engineering Company*, Reeves Division, 1225 Seventh Street, Columbus, Ind.

VALVE-IN-HEAD tandem cylinders, type BVT, consist of a valve-in-head cylinder and a double-acting cylinder mounted in line. Each unit has a common head at the center and two separate pistons mounted on one solid rod.



The rods are stainless steel, and the brass, or steel, tubes are treated for corrosion. Units are intended to combine all the advantages of valve-in-head cylinders with those of hydraulic control of an air-operated cylinder. The hydraulic fluid can be used either in the front cylinder or in the middle section of the unit without a make-up chamber. Air speed controls are provided in the valve section. Hydraulic speed control is obtained simply by piping flow control valves in series with the two ports used for the hydraulic section. Using air pressure in both sections, the usable force available is twice as great as the force obtainable from a standard cylinder of same bore size. This permits their use in spaces too small for larger bore standard cylinders. The cylinders are available in bore sizes of $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3 and 4 inches and in lengths to 80 inches. Several mounts and 48 models of valve-in-head cylinders for the power section are offered. *Allenair Corporation*, 225 E. Second Street, Mineola, N. Y.

FIVE VALVES in one—this is the Pneu-Hydro Multifunction Pressurizing Valve. Models presently in production feature a compact high-strength aluminum body combining a pressure cartridge opening valve, a pressure-reducing valve, an upstream relief valve, a fill valve and a downstream relief valve. Yet, the complete unit will fit within a $3 \times 4\frac{7}{8} \times 5\frac{3}{8}$-inch envelope. The model shown is designed for inlet pressure to 5000 psig with a constant outlet pressure set in the range of 200 to 1200 psig. Actuation is accomplished by a low momentary

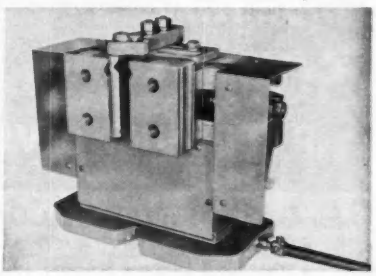


current source. Upon actuation, there is no metal fragmentation. The design is such that the sheared disc is contained from the flow path. This item was developed primarily as a control valve for pneumatically pressurized propellant systems. However, since a large number of valve combinations may be used with the reducer housing, this basic design becomes highly versatile. *Pneu-Hydro Valve Corporation*, 52 Horse Hill Road, Cedar Knolls, N. J.

FINGERTIP control valves with Swagelok connections for $\frac{1}{4}$-inch O. D. tube sizes are available from Whitey Research Tool Company. Called Series No. 1, the valves are brass or type 316 stainless steel, in straight and angle pattern styles. They have a 3000-psig pressure rating with a 0.172-inch orifice diameter.

With forged bodies, the devices are available with either microregulating or nonregulating stems. All stems are machined from type 316 stainless. Teflon cylinder packing and panel mounting nuts are also standard. *Whitey Research Tool Company*, 5525 Marshall Street, Oakland 8, Calif.

SURE-CENTER is an automatically self-centering work-holding device that operates from shop air lines. It is suited for drilling, tapping, milling, counterboring and reaming, as well as a screw-machine secondary operation on round, hex or square stock, standard or odd-shaped, smooth or rough castings. The device consists of two movable, gibbed master jaws, working from levers connected to a cam which will repeatedly center a workpiece within 0.0015 inch. The jaws can be set to drill the mean off-center, as well as for accurate center drill-



ing. It gives precise and instantaneous operations, visibility and adequate chip room. Holding force is reported to be more than 5500 pounds at 100 psig line pressure. Maximum jaw opening is 2.5 inches. Operation is by foot pedal, hand valve or valve connected with automatic equipment. *Heuser-Manufacturing Company*, 1638 N. Paulina Street, Chicago 22, Ill.

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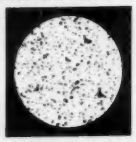

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WALDRON Series "M" Couplings

The new Series M couplings—with nylon gears and steel sleeves—need no lubrication. Equipped with Taper-Lock bushings—each coupling size can accommodate a range of shaft sizes. For instance, the 162M, now available, will take shafts from ⅛" to 1⅝" with proper size Taper-Lock bushings, and up to 2" without the bushings. Hubs are machined from bar stock and the one piece sleeve is made of steel. This design means a smaller, light weight coupling that is easier to install and maintain and yet can transmit the necessary power. Size 162, Series M gear couplings can be used for continuous operation up to 5000 rpm at torques up to approximately 2000 inch pounds.

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MIDLAND-ROSS CORPORATION
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- 200# range with tamper-proof adjustment
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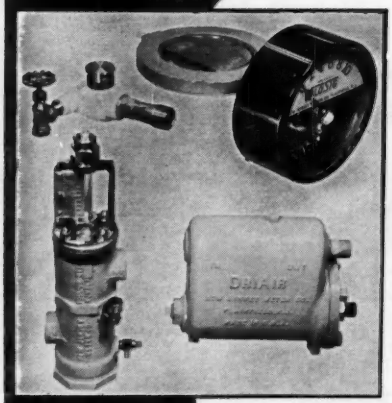

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Flow control problems stop being problems when you specify New Jersey Meter Units. Air Meters, the only pulsation compensated units available; Dri-Air Separators to remove water, oil, rust, scale and sediment from lines; Flo Sig Electric Signal Flow Indicators that report trouble before it happens; and Blowers especially adapted for furnaces and many modern applications.

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SNOOP, a liquid leak detector, has a fine bubbling action that detects leaks in pressurized air or gas lines. A thin, solid stream of Snoop is applied to test each connection. Bubbles form immediately if a leak is present. The solid stream method of application avoids bubble formation from spraying which has been a nuisance in the past. Long bubble life

and positive indication of minute leaks are reported special features of Snoop. It will even detect leaks at the bottom of connections in vertical runs where gravity tends to remove other testing fluids. Snoop comes in an 8-ounce polyethylene squeeze bottle with a $^1/_8$-inch Snooper tube that has an adjustable length from $^1/_2$ inch to 12 inches. Using the tube fully extended aids application in hard to reach locations and restricted areas. Snoop is available for immediate delivery. *Nuclear Products Company,* 15636 Saranac Road, Cleveland 10, Ohio.

SPRAY DRIERS of special design for pilot plant and hard-to-dry materials, and moderate-production driers (to 20 tons a day), are discussed in a 4-page bulletin, No. 37. Besides capacity information, the booklet covers specifications of air heating, chamber sizes and construction, atomization, duct arrangement, production collection and accessory instrumentation. Erection information and details about space requirements are also given. *Bowen Engineering, Inc.,* North Branch, N. J.

MECHANICALLY and manually operated air control valves are cataloged for quick reference and specification. The booklet covers $^1/_4$-inch NPT 2-position balanced spool valves and normally closed or normally open 2-, 3- and 4-way styles. The line utilizes the exclusive Hoffman valve segment that makes possible thousands of different valve styles constructed from less than 50 standard parts. A 3-page section presents all model numbers, specifications and operators in one easy-to-read chart. Copies

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Adams offers this outstanding performance at substantial savings, made possible through specialization in Aftercoolers and Cyclone Separators — plus quality manufacturing methods developed over the years.

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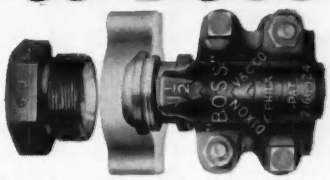
ADAMS QUALITY COMES THROUGH

"GJ-BOSS"



GROUND-JOINT FEMALE COUPLING, STYLE X-34

SO *Reliable* FOR PILE DRIVING

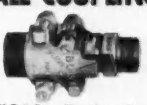
...AND ANY STEAM, AIR, WATER AND HYDRAULIC SERVICES...

HIGH OR LOW PRESSURE

Washerless

Unequalled for safety, efficiency and long service life. Ground-joint union between stem and spud provides leak-proof, trouble-free seal... no lost or worn-out washers to replace. All parts malleable iron or steel, rustproofed. Furnished with superstrong "Boss" Offset and Interlocking Clamps. Sizes ¼" to 6", inclusive.

COMPANION MALE COUPLING "BOSS" STYLE MX-16



Companion coupling for "GJ-Boss", described above, and "Boss" Washer Type Couplings Style W-16. Each size fits same size hose... oversize hose not required. Furnished with "Boss" Offset and Interlocking Clamp. Sizes ¼" to 6", inclusive.

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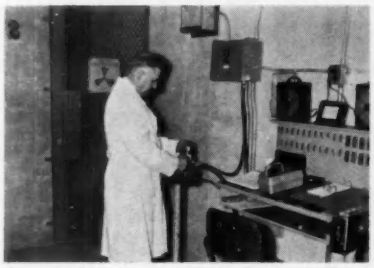
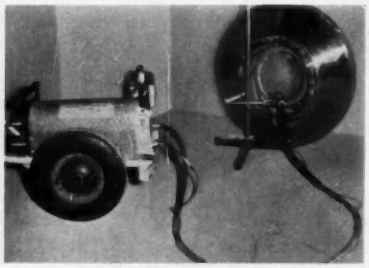
We inspect centrifugal compressors *from the inside-out* at our new Non-Destructive Testing Laboratory. Using cobalt 60, iridium 192 or 160-KV X-ray equipment, we look all the way through centrifugal compressor parts to be certain they are free from defects. This extra care in manufacture means extra dependability in the field. It's another reason why users of Ingersoll-Rand centrifugal compressors can expect...and get...more reliable, trouble-free operation.

Controlled from a remote station...gamma rays probe deep...to provide visible internal inspection



At one of 3 test stations, an Ingersoll-Rand radiographer uses remote controls to place radioactive pellets of iridium or cobalt in the exposed position...



...within the thick concrete test cell. The gamma rays penetrate the compressor part and expose the film. The radioactive pellet is then returned to its shielded container.

The developed radiographic view is carefully inspected by I-R metallurgists to be certain that the part is free from defects. Radiography is one of many non-destructive testing methods used by Ingersoll-Rand.

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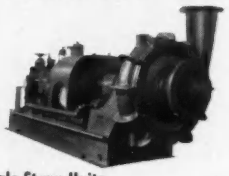
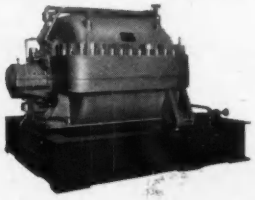
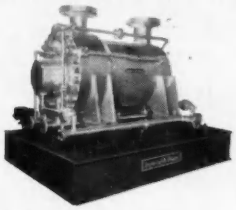
MORE TYPES AND SIZES to choose from



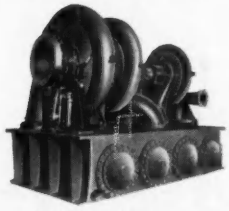
Single-Stage Units
Pressures to 1000 psi
Capacities to 700,000 cfm



Multi-Stage, Horizontally Split
Pressures to 800 psi
Capacities to 200,000 cfm



Multi-Stage, Vertically Split
Pressures to 5500 psi
Capacities to 20,000 cfm



Intercooled 100-psi Units

These four basic casing types can be combined into multiple-unit installations to meet any pressure and capacity requirement. And every design features . . .

GREATER ADAPTABILITY to meet your specific needs. Seals, cooling methods and side-load connections are just a few of the many design details that can be "tailored" to each installation. What's more, every compressor is backed by . . .

MORE THOROUGH TESTING in the world's largest and best-equipped compressor test facility. Here new centrifugal designs, components, accessories and complete machines can be tested, frequently at full load and under simulated operating conditions.

5 MILLION HORSEPOWER of I-R centrifugal compressors are serving all types of applications throughout industry. 263A12

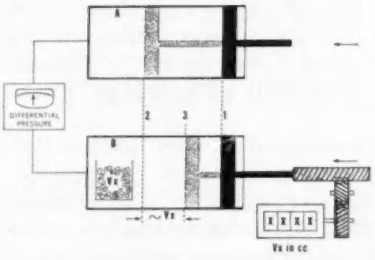
Ingersoll-Rand
11 Broadway, New York 4, N. Y.

of Bulletin 60-1 are available to qualified individuals. *Hoffman Valves, Inc.*, 2360 W. Dorothy Lane, Dayton 39, Ohio.

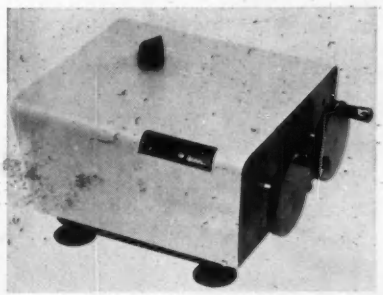
NATIONAL MACHINE has taken pity on the engineering and production department's shortage of reading time by publishing a 16-page condensus of the 144-page catalog. All basic engineering data and specifications are included concerning hexagon nuts, standard sizes $1/4$–3 inches; Conelok, Huglock and Marsden locknut sizes $1/4$–$1\,1/2$ inches; specials $7/16$–$4\,1/4$ inches; Weldnuts #10 to $5/8$ inch; 12 pointer nuts sizes $1/4$–$5/8$ inch; and 16 types of AN (Air Force-Navy aeronautical) Nuts. *National Machine Products Company*, Utica, Mich.

A PIPELINE consistency regulator, which continually controls and records on an arbitrary scale the consistency of pulp stock is described in Specification Bulletin No. 16C2381. The system is made up of a shear float sensitive to consistency and contained in a special high-outlet tee, a pneumatic force transmitter, and a special 2-pen recording controller. Components, materials of construction, performance characteristics, design features and capacities are also given. *Fischer & Porter Company*, 802 Jacksonville Road, Warminster, Pa.

MODEL 930 Air Comparison Pycnometer is designed for rapid measurements of volume, density and porosity of irregular, powdered, or porous solids. The instrument requires no liquids, gas pressure determination, or temperature control. True volume measurement is provided for specific gravity and density in such applications as mineral identification, chemical mixture determination, and porosity evaluation of sintered and porous materials. The measurement is nondestructive and can be completed in less than 1 minute.



The unit (*see drawing*) has two identical volume chambers and two pistons, A and B. With no sample in either cylinder, any stroke in one must be equaled by an identical stroke in the other for the differential pressure gauge to read zero. With both pistons at position 1, a sample (V_x) is inserted into chamber B. Cylinder A is compressed to position 2. Piston in B is stroked to position 3, the point at which the differential pressure gauge reads zero. The difference in displacement between positions 3 and 2 is directly proportional to the unknown volume V, and is read directly in cubic centimeters on the counter, which is calibrated from the reference position 2. If two systems contain an identical gas at the same temperature and pressure, the specific volume is identical in both systems. In the pycnometer the specific volume of the air is equal between cylinders A and B before and after compression. The air on both sides quickly reaches the temperature of the cylinders. Accuracy is not dependent on Boyle's Law but depends only on machining accuracy and the requirement that the mass of air be equal before and after compression (i.e., that both systems are sealed).



To make a reading, the operator rotates a valve and adjusts the two handwheels to obtain a zero pressure differential reading between the two cylinders. No special training is required and no power source is needed. The instrument reads digitally in tenths of a cubic centimeter for total volumes to 50 cubic centimeters. Measuring 6 x 9 x $10\,1/2$ inches, the pycnometer weighs 14 pounds. Further information on the unit may be obtained by writing to the manufacturer's Technical Information Department for Bulletin 786. *Beckman Scientific & Process Instruments Division*, Fullerton, Calif.

CONSTRUCTION men will be interested in a comprehensive booklet that catalogs a complete line of abrasives and related products for the masonry and concrete trades. The 42-page production is a quick-reference, reliable handbook. *The Carborundum Company*, Advertising Branch, P.O. Box 337, Niagara Falls, N. Y.

ALTERNATING-CURRENT generators in ratings from 3.75 through 62.5 kva are described in a 2-page form. These machines are nonpackaged—without voltage regulators. They feature a

Koppers supplies packaged piston ring set for Caterpillar's husky D8 crawler Tractor

Extra stamina is demanded of every part of Caterpillar's massive D8 Tractor because it's built to push or pull the heaviest loads over the roughest terrain. This "something extra" is evident in the D8's powerful 235 HP turbocharged diesel engine—complete with packaged piston ring sets by Koppers.

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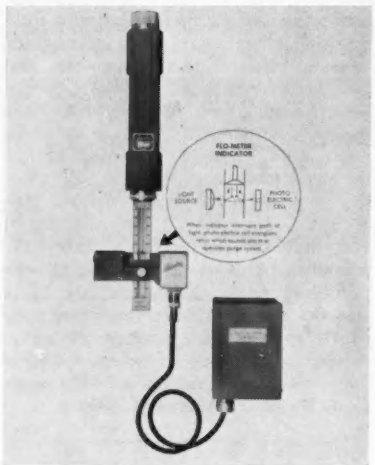
That's a completely Koppers ring equipped piston you're looking at. From the precision lapped, chromium plated, high strength alloyed iron compression ring in its top groove to the chromium plated, conformable, spring loaded, ventilated oil ring in the bottom groove. This set-up guarantees fast break-in and longer life resulting in peak efficiency for Caterpillar's 235 HP diesel engine.

heavy dripproof frame, easy accessibility, large terminal box, prelubricated bearings and end-to-end ventilation. Speeds are 1000 to 1800 rpm. All standard voltages and combinations are available. The generators are suitable for operation at either 60 or 50 cycles. Single- or 2-bearing construction is optional. Copies of Publication No. 2100-PRD-250 are available without charge. *Electric Machinery Manufacturing Company,* Minneapolis 13, Minn.

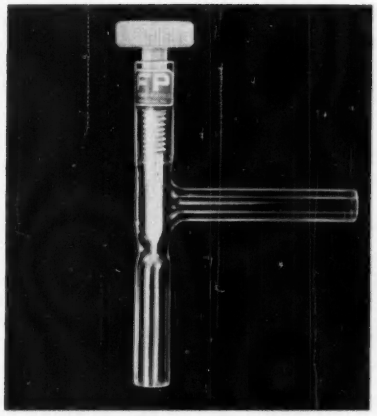
PROTECTION against hazards due to failure of flow of gas to a process or heat-treating furnace is provided by Flo-Alarm. It operates in conjunction with a standard Waukee Flo-Meter, utilizing the photoelectric principle shown in the schematic illustration. Should flow drop below a certain point (which is easily adjustable) the Flo-Meter indicator interrupts a light beam which is focused on the photoelectric cell and the Flo-Alarm



sounds a warning or operates a purge system. The alarm can be adapted to all meters ranging from 0-10 cfh through 0-30,000 cfh. A standard Flo-Alarm can be used for either low or high flow warning; if desired, a combination of two standard units can be used for both. The relay contacts, contained in the Flo-Alarm control, are rated 10 amperes at 110 v. *Waukee Engineering Company, Inc.,* 5150 N. Thirty-Fifth Street, Milwaukee 9, Wis.

WEIGHT computations for welded steel tubing are easily obtained from tables in a brochure prepared by Jones & Laughlin Steel Corporation. Tables in the handy 16-page booklet give dimensions and weight-per-foot for round, rectangular and pressure tubing. A full-page chart presents decimal equivalents for fractional parts of a pipe foot. Another gives diameters and weights for pipe sizes (plain ends). *Jones & Laughlin Steel Corporation,* Electricweld Tube Division, 3 Gateway Center, Pittsburgh 30, Pa.

THIS threaded-glass and Teflon needle valve provides fine fluid control and permits continuous visual observation of flow. The glass tube itself is threaded by a Fischer & Porter process that eliminates conventional metal threads and



allows simplified 2-piece construction. The wetted tip of the glass needle valve is of chemically inert Teflon, which will not corrode or leak; the needle valve stem, which is made of Kel-F, is sealed with an O-ring of Viton A. The valve has a maximum orifice of 0.005 inch and has been reported to have been used successfully in vacuum applications down to 10^{-4} mm Hg. *Fischer & Porter Company,* 720 Jacksonville Road, Warminster, Pa.

Books . . .

Advances in Cryogenic Engineering (published by Consultants Bureau Enterprises, Inc., Plenum Press Inc., 227 W. Seventeenth Street, New York 11, N. Y.) is the sixth volume of a series dealing with cryogenics and low-temperature phenomena. It was edited by K. D. Timmerhaus, and contains the proceedings of the 1960 Cryogenic Engineering Conference held by the University of Colorado and the National Bureau of Standards. There are 65 technical papers by leading scientists in cyrogenic engineering. The reports are divided into the following sections: Space Technology, Applications, Superconductivity, Processes, Transfer Phenomena, Equipment, Physical Equilibria & Related Properties, Heat Transfer & Thermometry, and Mechanical Properties. This continuing series of volumes enables every scientist and technician interested in cryogenics to keep

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fully informed of new developments in the field. The first five volumes are still available and cost $13.50 each ($15.00 foreign). If volumes 1–4 are purchased as a set, the cost is $35.00 ($40.00 foreign). Complete tables of contents are available without charge from the publisher. 652 pages. Cost, Vol. 6 $15 ($17.50 foreign).

Handbook of Welded Steel Tubing (published by Welded Steel Tube Institute, 1604 Hanna Building, Cleveland 15, Ohio) is a comprehensive new manual about welded steel tubing. It details the newest technological advances made in production and fabrication of welded steel tubing. The volume compiles engineering data as an aid in simplifying the work of engineers, fabricators, architects, designers—all who work with tubular products. Included for the first time in the fabrication section is a completely illustrated chapter about joining methods as applied to welded steel tubing. This includes both welded and mechanical methods. Also featured are complete requirements for successful bending, swaging, expanding, flanging and beading, and upsetting. The handbook consists of four main parts, each subdivided into several sections. More than 140 pages, including a complete index and illustrations, are devoted to carbon steel tubing. Included are 48 pages of tables and design data and a 27-page section serving as a glossary of terms and definitions.

The Welded Steel Tube Institute is an association of eighteen leading manufacturers of tubes formed and welded from flat-rolled carbon and stainless steel. It was established 30 years ago to make available information common to fabricators of welded stainless and carbon steel tubing. Periodically it publishes the Handbook as the official technical reference book of the industry. Cost, $10.

The Handbook of Thermophysical Properties of Solid Materials (published by The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y.) is a 5-volume work that is to be published in August. However, copies will be available as early as June and they will be sold at a reduced price. Vital information on twelve major properties of solid materials—elements, alloys, ceramics, cermets, intermetallics, polymerics and composites—that melt above 1000° F was collected, evaluated and consolidated by a team at Armour Research Foundation. The U. S. Air Force saw the need to make this jumble of information available in one source for government contractors in missile, aircraft and nuclear science fields, and commissioned Armour to compile all the published data. Now, the Air Force and the publisher have combined their efforts to make the book available to everyone interested in thermophysical properties of solid materials. 4300 pages. Cost, $75 (after August 14, $90).

Hydraulic and pneumatic lines are quickly and easily connected with Hansen Two-Way Shut-Off Couplings. No tools required.

When coupling is disconnected, valves contact valve seats in both Socket and Plug to provide instant and positive seal of fluid in both ends of line. Coupling does not depend upon line pressure to seal either end of line.

Hansen Series HK Couplings are furnished in steel or brass, with female pipe thread connections from ⅛" to 1½" respectively. Sizes up to 1" are also now available in stainless steel.

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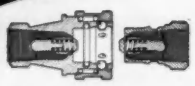

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Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings.

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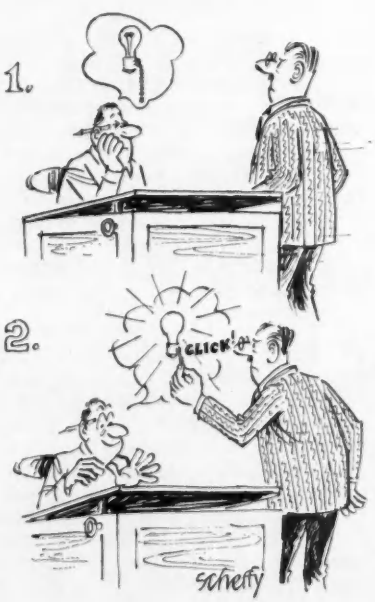
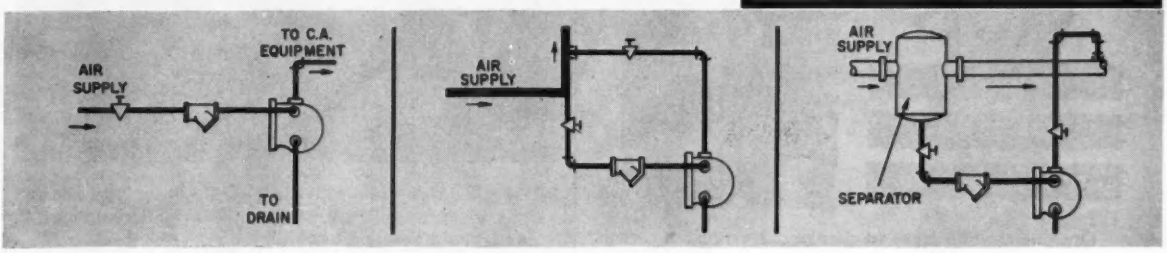


Get more work from your CA tools with NEW SARCO FA DRAIN TRAPS

Cross-section of Type FA Drain Trap shows float design that keeps condensate level above trap, providing seal against air leakage.



The true measure of effective air compressor capacity is effective work done by your compressed air tools. These tools will perform *more* useful work when you install Sarco Automatic Drain Traps. Typical hookups above show how Sarco Type FA Traps keep condensate level in the trap body *above* the valve.

They maintain positive seal against air leakage and give you the steady supply of dry air that means full power. Dry air also cuts maintenance . . . prevents damage to tools from water hammer and impaired lubrication . . . and prevents the freezing in the tool exhaust that can mean slowed production. Write for Bulletin 520, full of ideas that can help increase effectiveness of your present air compressor capacity. 6351

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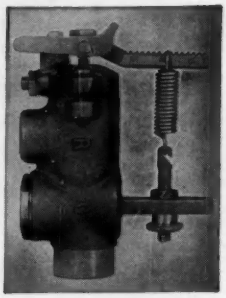
24 HOUR SERVICE

Factory Rebuilt UNLOADER VALVES



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any make
any condition

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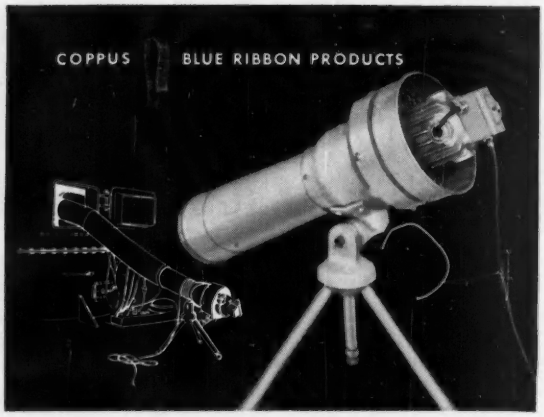

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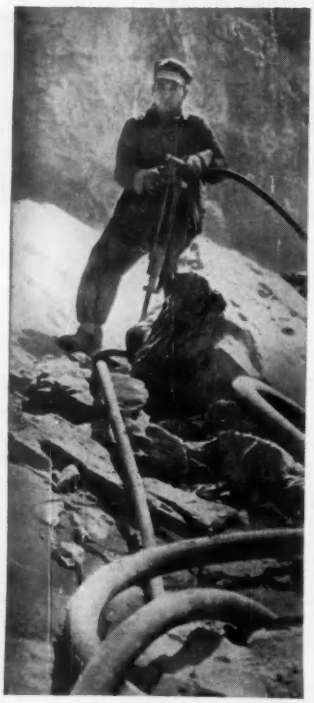

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- **STRONG**
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More flexible and lighter than any other hose for equal pressure. Lasts longer, precision built, uniform diameter, lower end cost. Made also in extra-heavy type for mining.

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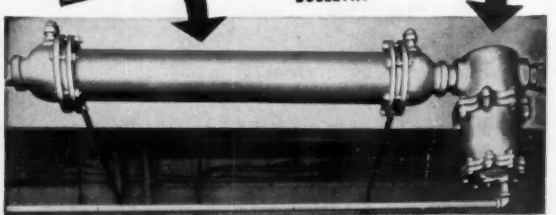

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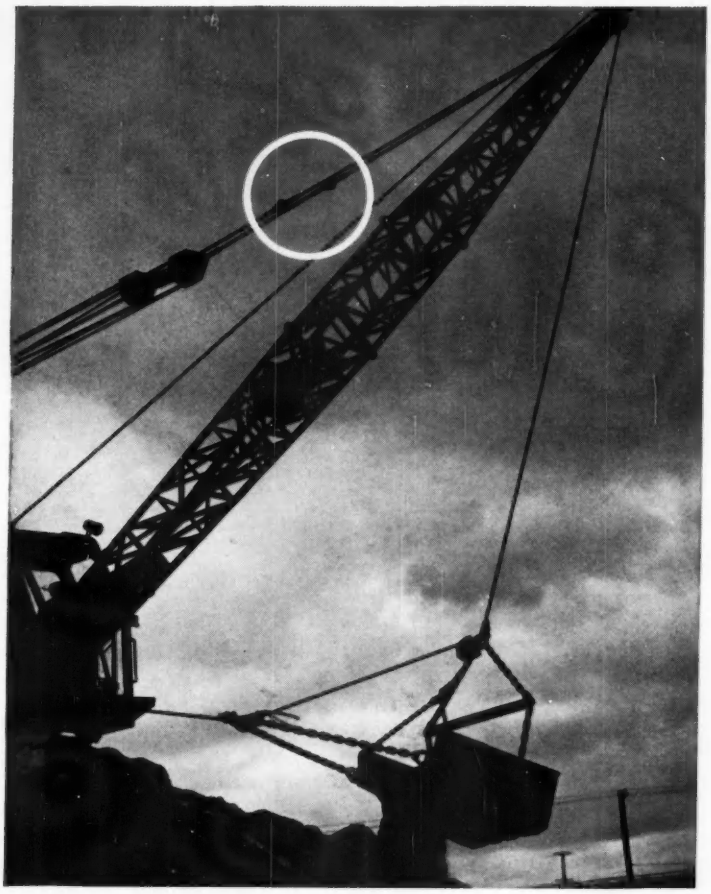

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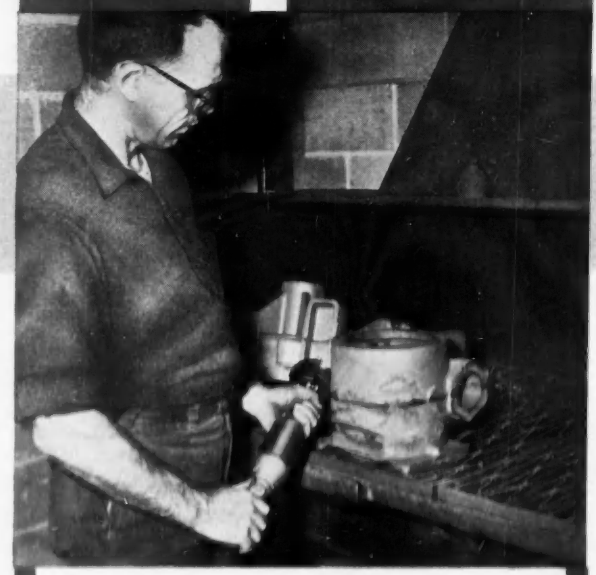

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215A-8

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